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Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

Predicción climática decadal: experiencia y perspectivas

J. García-Serrano

Climate Prediction Group
Earth Sciences Dept. (BSC-ES)

European Commission
MSCA-IF-EF

based on our work during 2010-2016 at IC3 + BSC-ES

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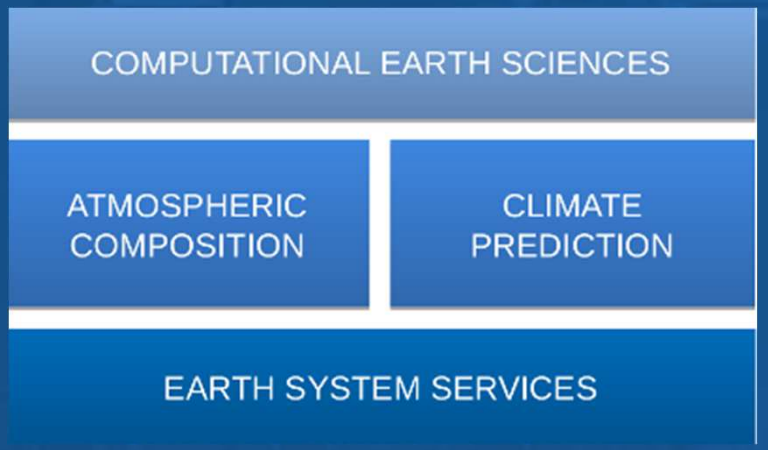
CFU

Climate Forecasting Unit

2010-2015

2015-2016



IC3 INSTITUT CATALÀ DE CIÈNCIES DEL CLIMA

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Multi-model decadal forecast exchange

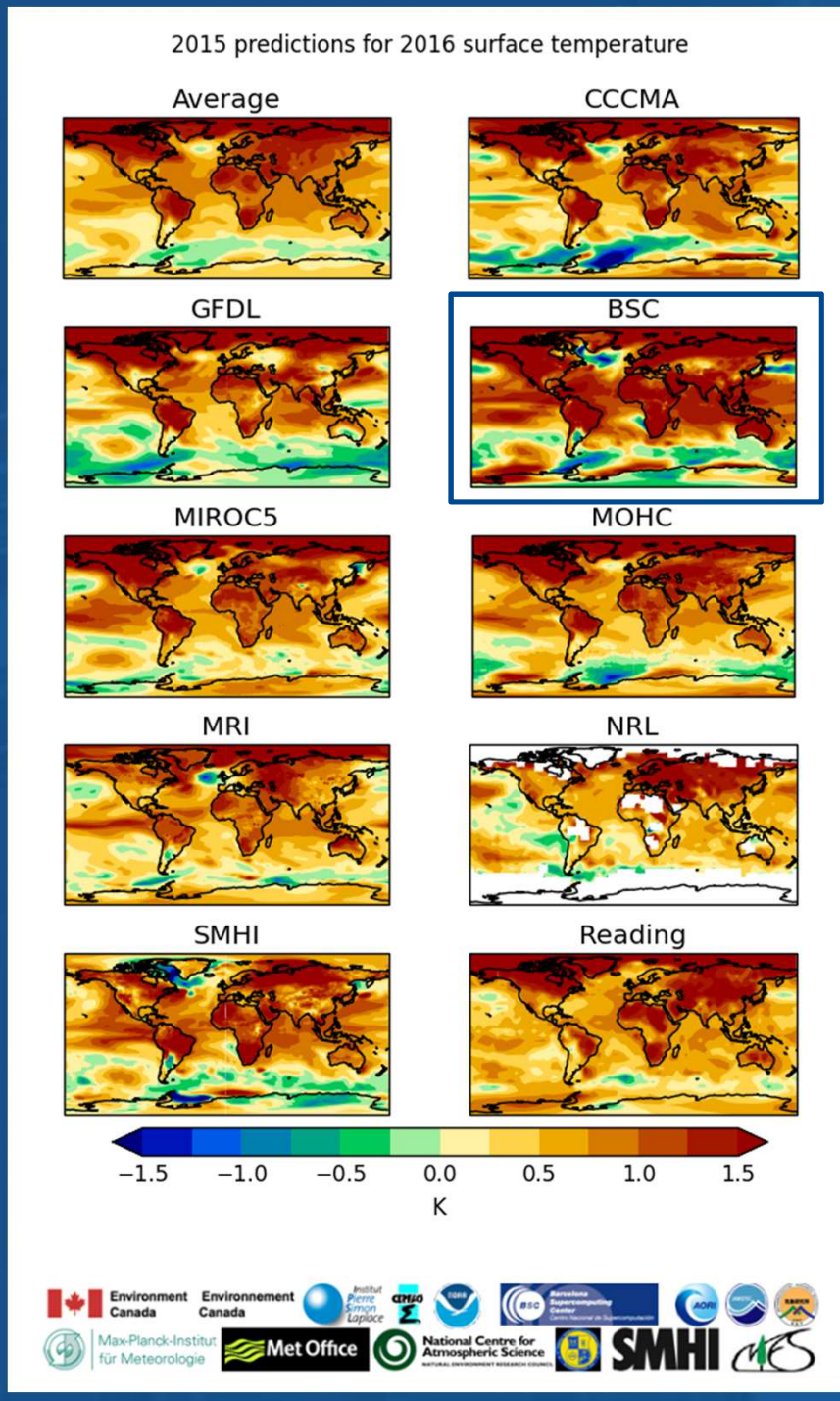
The Met Office coordinates an informal exchange of near-real time decadal predictions. Many institutions around the world are developing decadal prediction capability and this informal exchange is intended to facilitate research and collaboration on the topic.

The contributing prediction systems are a mixture of dynamical and statistical methods. The prediction from each institute is shown below, alongside an average of all the models. When possible, observations for the period of the forecast are also shown. Currently three variables are included: surface air temperature, sea-level pressure and precipitation. These are shown as differences from the 1971-2000 baseline. More diagnostics, including ocean variables are planned for the future. Please use the drop-down menus below to explore the data collected to date.

This work is supported by the European Commission SPECS project.

SPECS
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Smith et al. (2013, ClimDyn) - UPDATED



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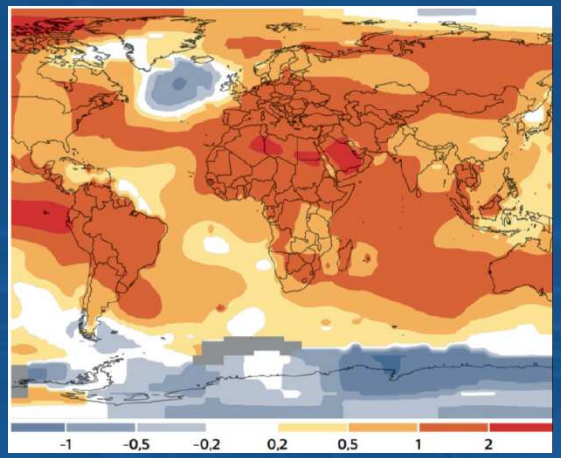
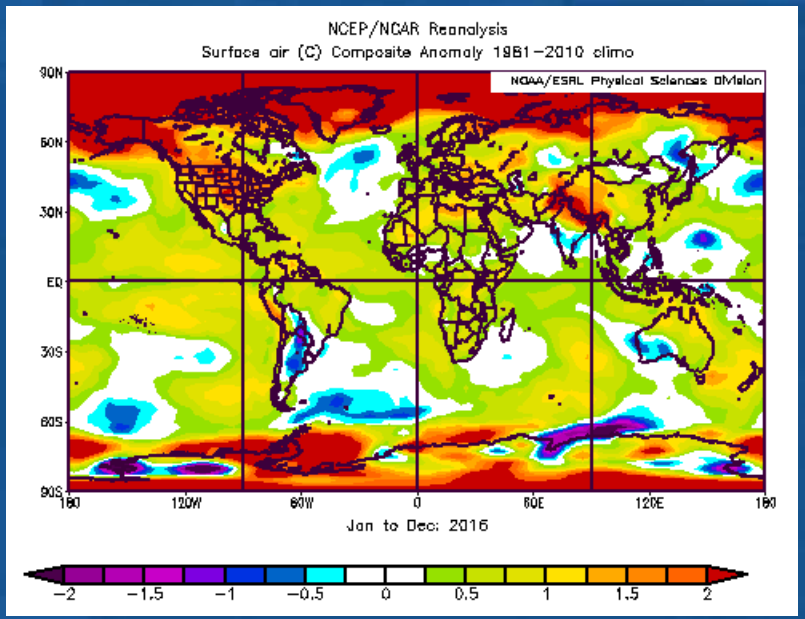
May-Oct 2015

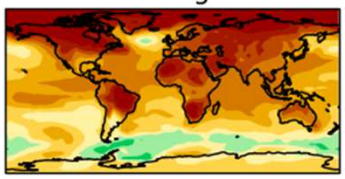


Jan-Dec 2016

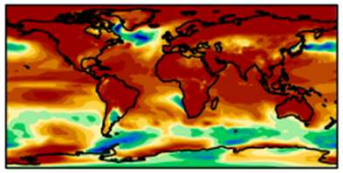


2015 predictions for 2016 surface temperature

Average



BSC



Environment Canada Environnement Canada
Max-Planck-Institut für Meteorologie
Met Office
National Centre for Atmospheric Science
SMHI

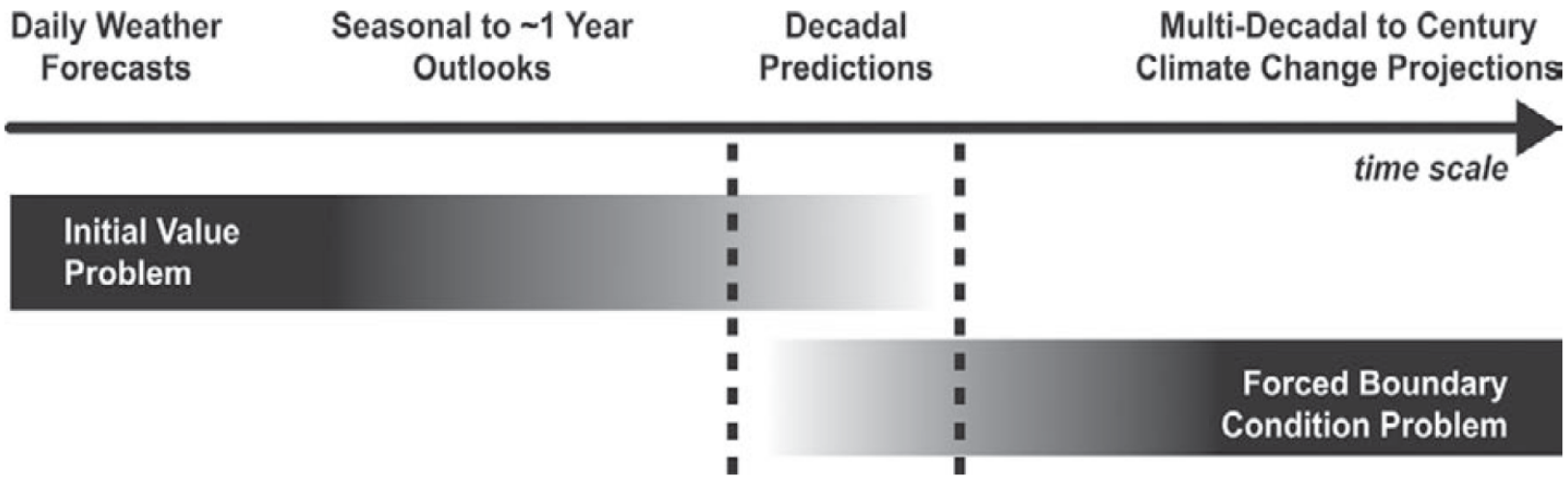
Decadal climate prediction

- Decadal prediction bridges seasonal forecasting and climate-change projection

- The decadal timescale is a key planning horizon for adaptation/decision making

- Decadal prediction not only deals with anthropogenically forced variability, but also with natural (unforced) internal variability

- Decadal prediction opens the possibility of achieving skill in multi-year timescales, and in both regional and large-scale domains



Meehl et al. (2009, BAMS)

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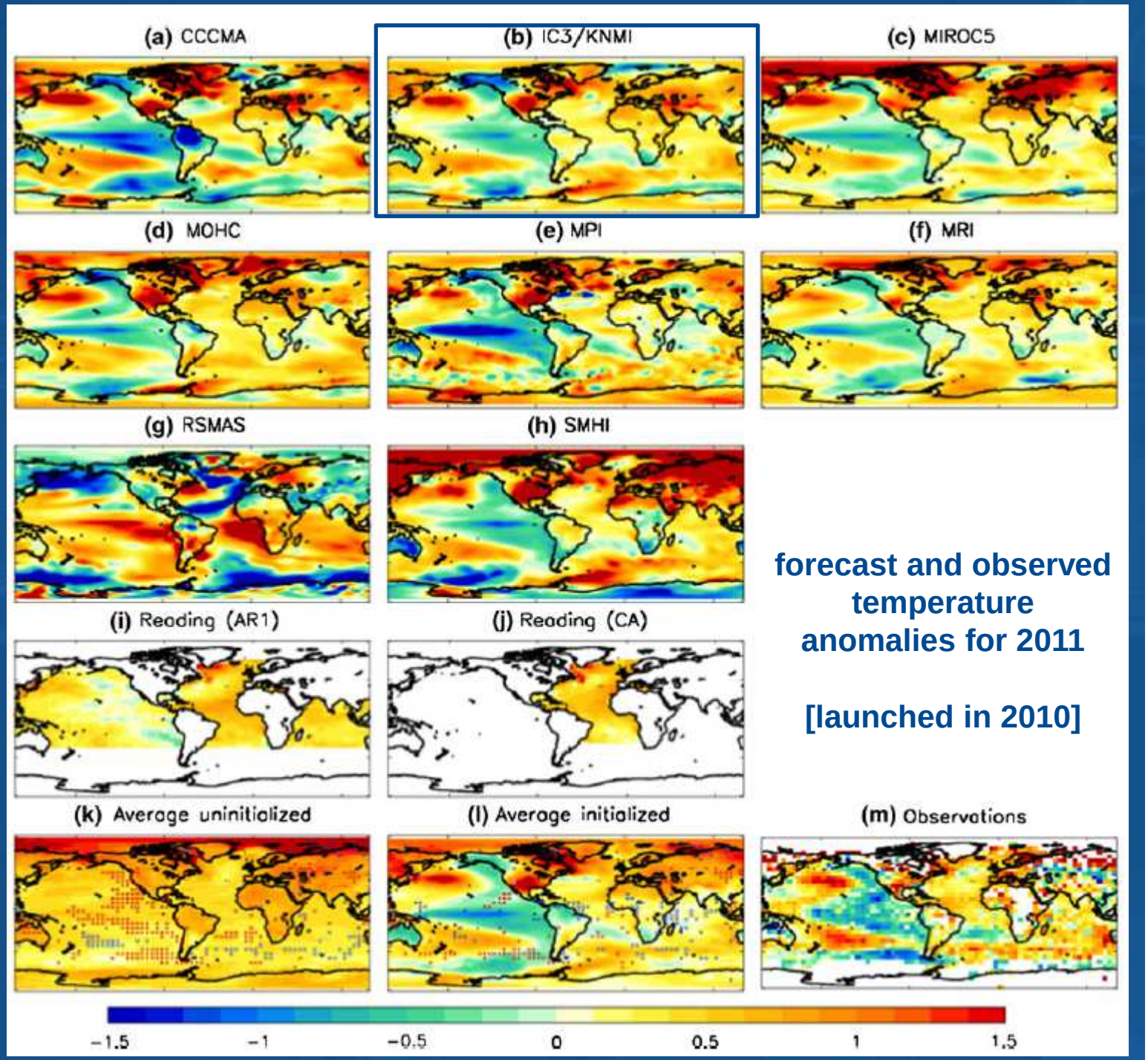


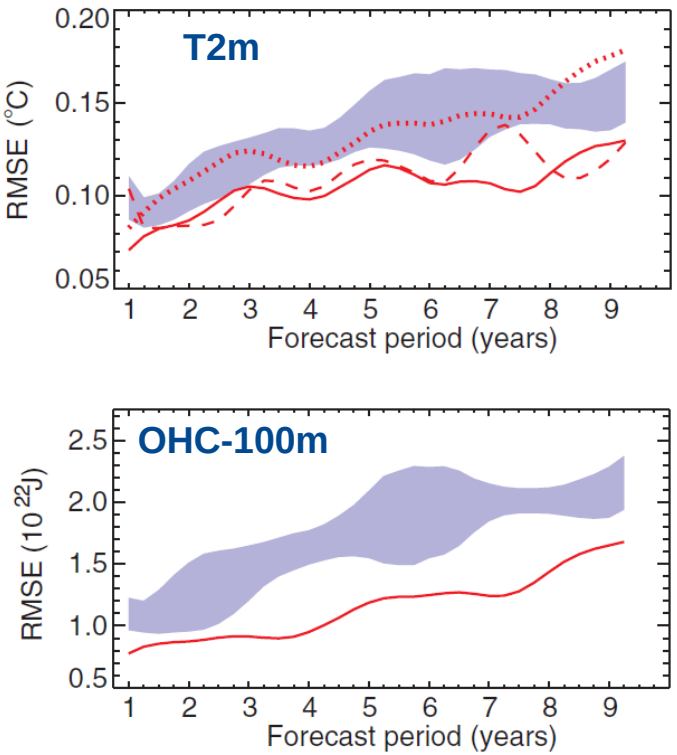
forecast and observed temperature anomalies for 2011

[launched in 2010]

Smith et al. (2013)

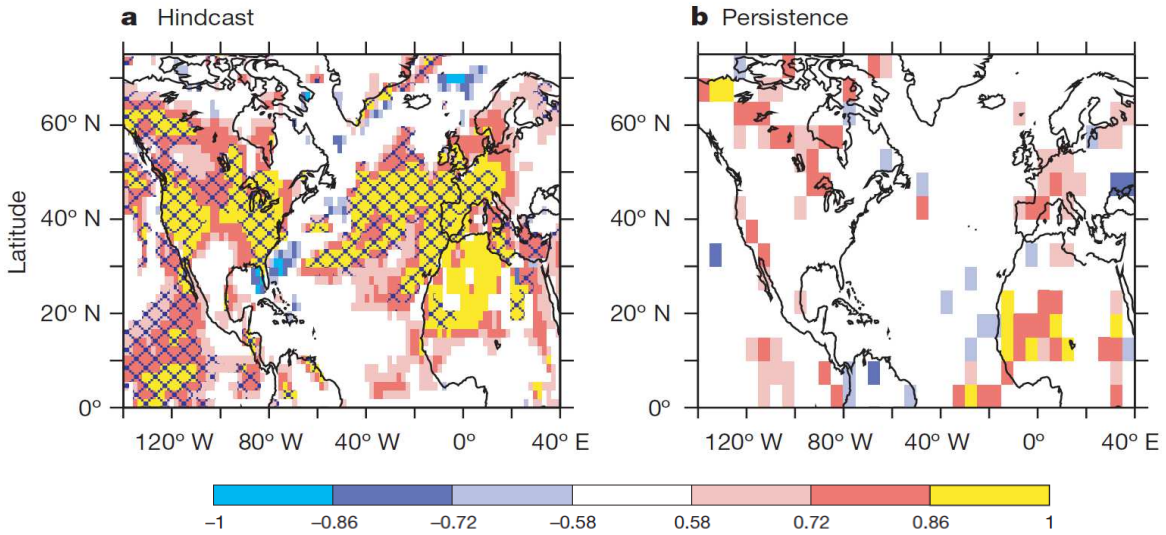
Decadal climate prediction

DePreSys (UKMO)

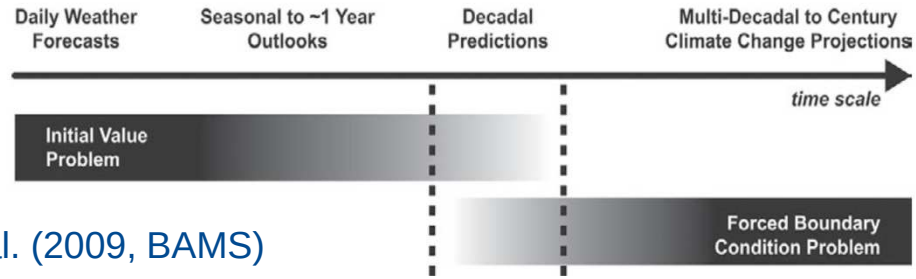


Smith et al. (2007, Science)

ECHAM5/MPI-OM (GEOMAR & MPI)



Keenlyside et al. (2008, Nature)



Meehl et al. (2009, BAMS)

Decadal climate prediction

DePreSys (UKMO)

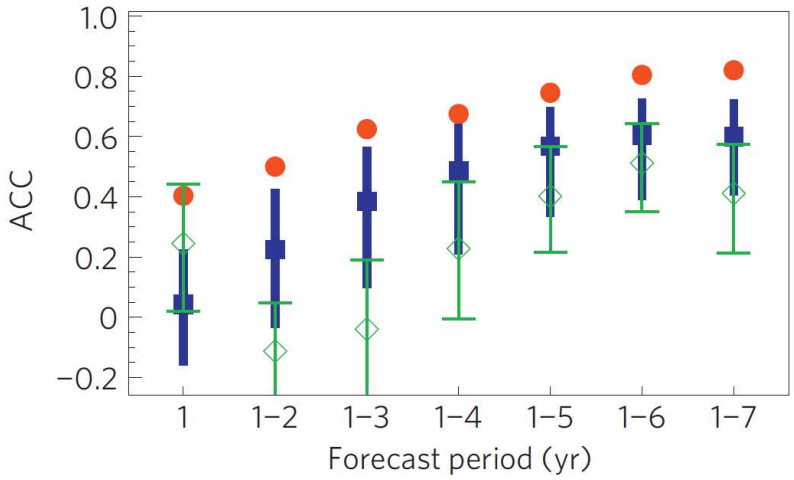
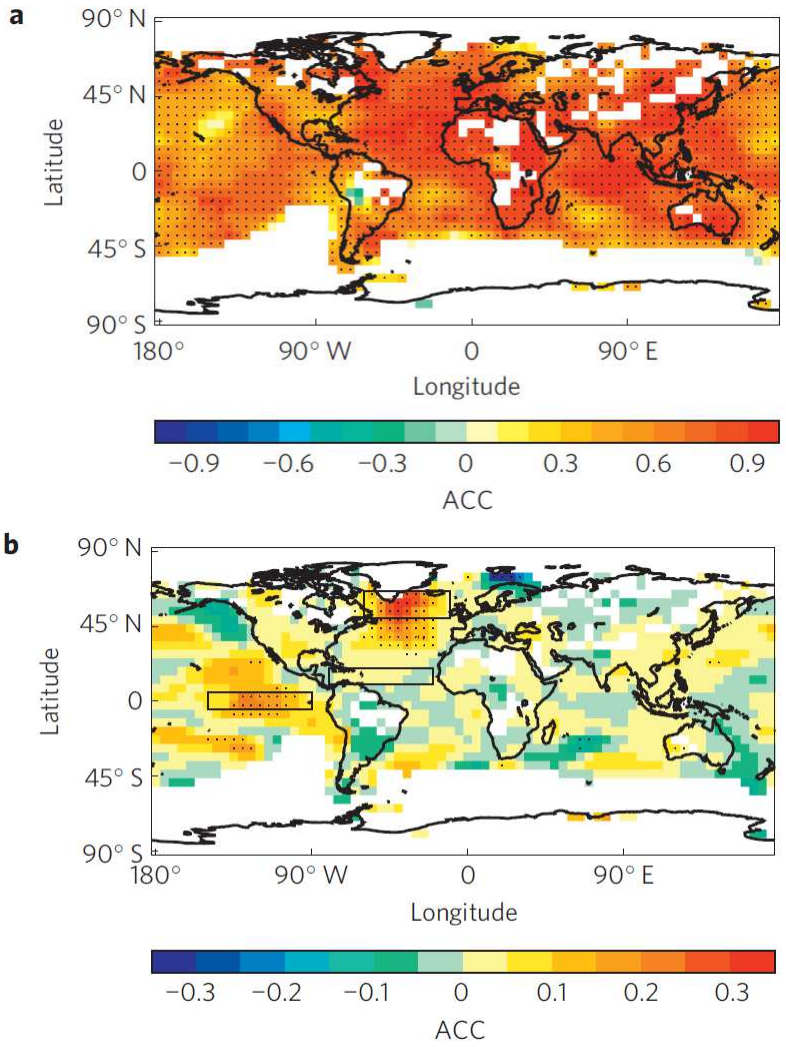


Figure 2 | Multi-annual hindcasts of Atlantic tropical storm frequency. **a**, ACC (see Supplementary Information) for predictions of the number of Atlantic tropical storms for increasing forecast periods. Forecast period '1' is the first hurricane season (months 8–13 from November hindcasts), and '1–7' is the average of years 1–7 inclusive. Initialized predictions (DePreSys, red circles) are compared with externally forced (NoAssim, blue squares) and persistence (green diamonds, see the Methods section), with the blue/green bars indicating the 5–95% confidence interval in which differences in skill from DePreSys are not significant (see Supplementary Information).

Smith et al. (2010, Nature Geoscience)



ACC between 5-year mean (Jun-Nov) surface temperature predicted by DePreSys-Assim and HadCRUT3 (**a**); ACC difference between Assim and NoAssim (**b**)

Decadal climate prediction → 'climate services'

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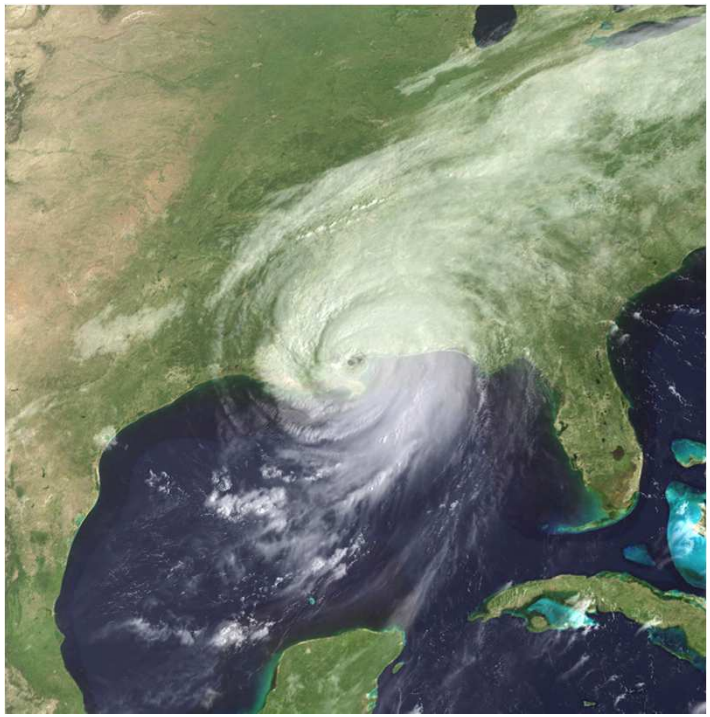
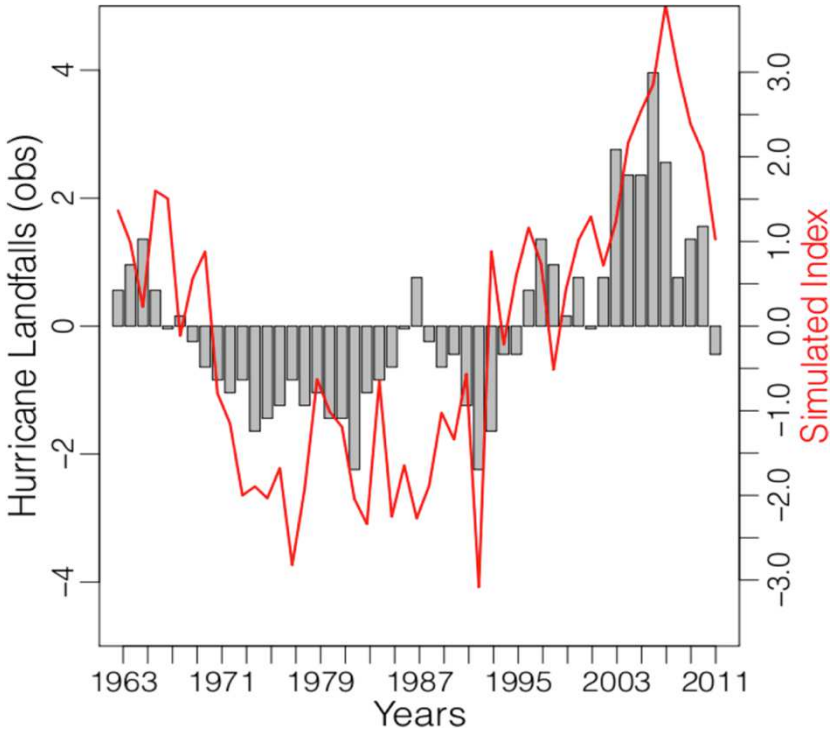
AMO is a predictor for tropical cyclone activity in the Atlantic. Decadal predictions over forecast years 1-5, including the Accumulated Cyclone Energy (ACE) diagnostic.

XL CATLIN - INSURANCE
XL CATLIN - REINSURANCE





Camp and Caron (2016, Springer)

SECTEUR:

Sector Engagement for the Copernicus Climate Change Service (C3S): Translating European User Requirements

Copernicus Europe's eyes on Earth

ON BEHALF OF ECMWF FOR THE EUROPEAN COMMISSION

Decadal climate prediction → 'climate services'

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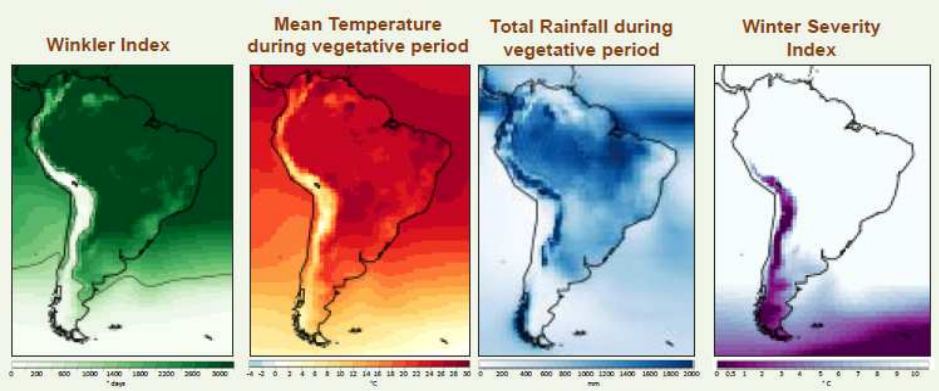
Bodegas Torres (a Spanish winery) is looking for new locations for its vineyards (and it's not the only one doing it).

Land is being purchased closer to the Pyrenees, at higher elevation. They are considering acquiring land in South America too, in areas where wine is currently not produced.

Bodegas Torres requests local climate information (including appropriate uncertainty assessments) for the vegetative cycle of the vine.



VIÑAS DEL VERO

SOGRAPE VINHOS

CODORNÍU

RAIMAT

TORRES
1870

Decadal climate prediction → 'climate services'

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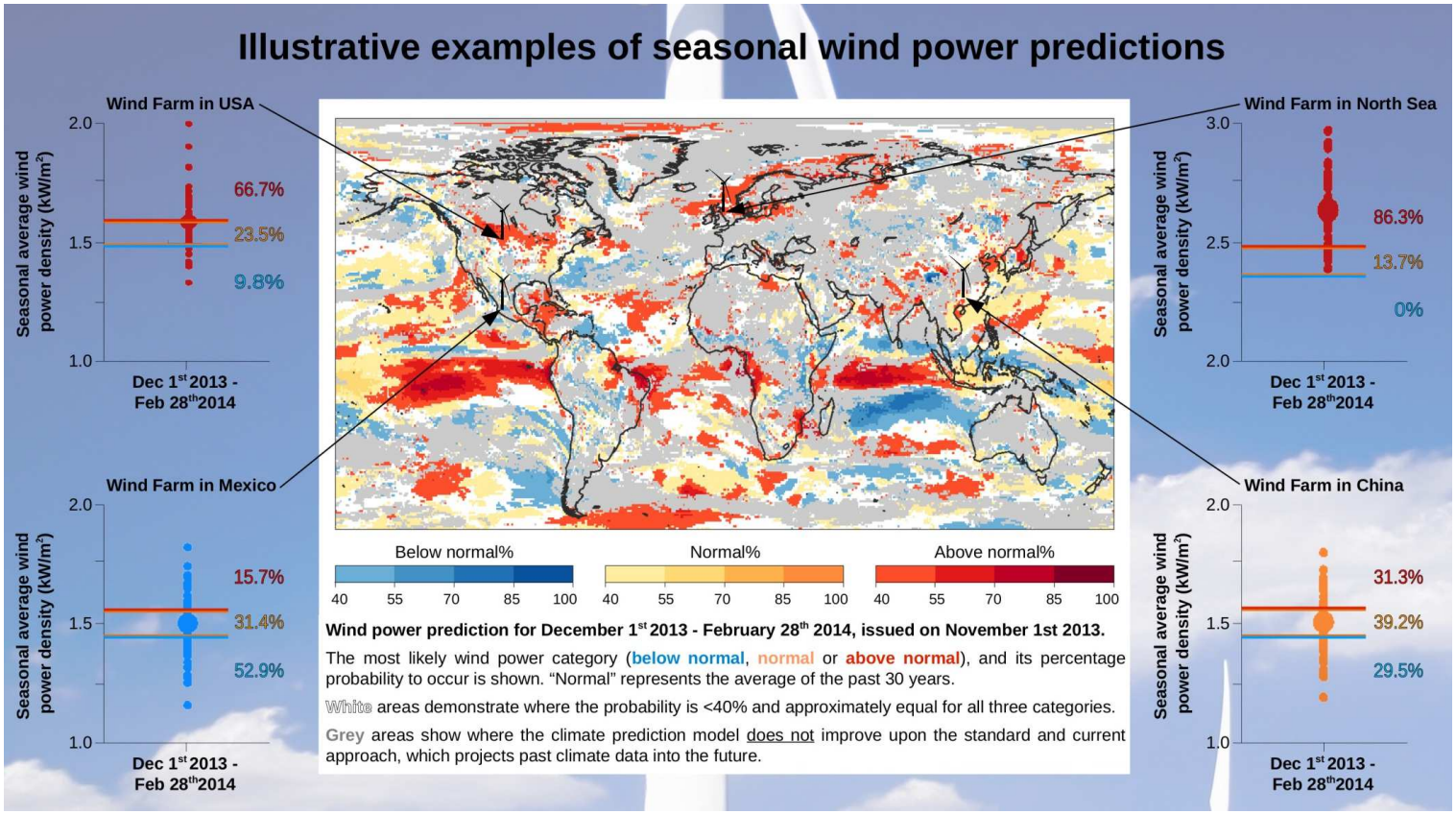
WIND POWER PREDICTION

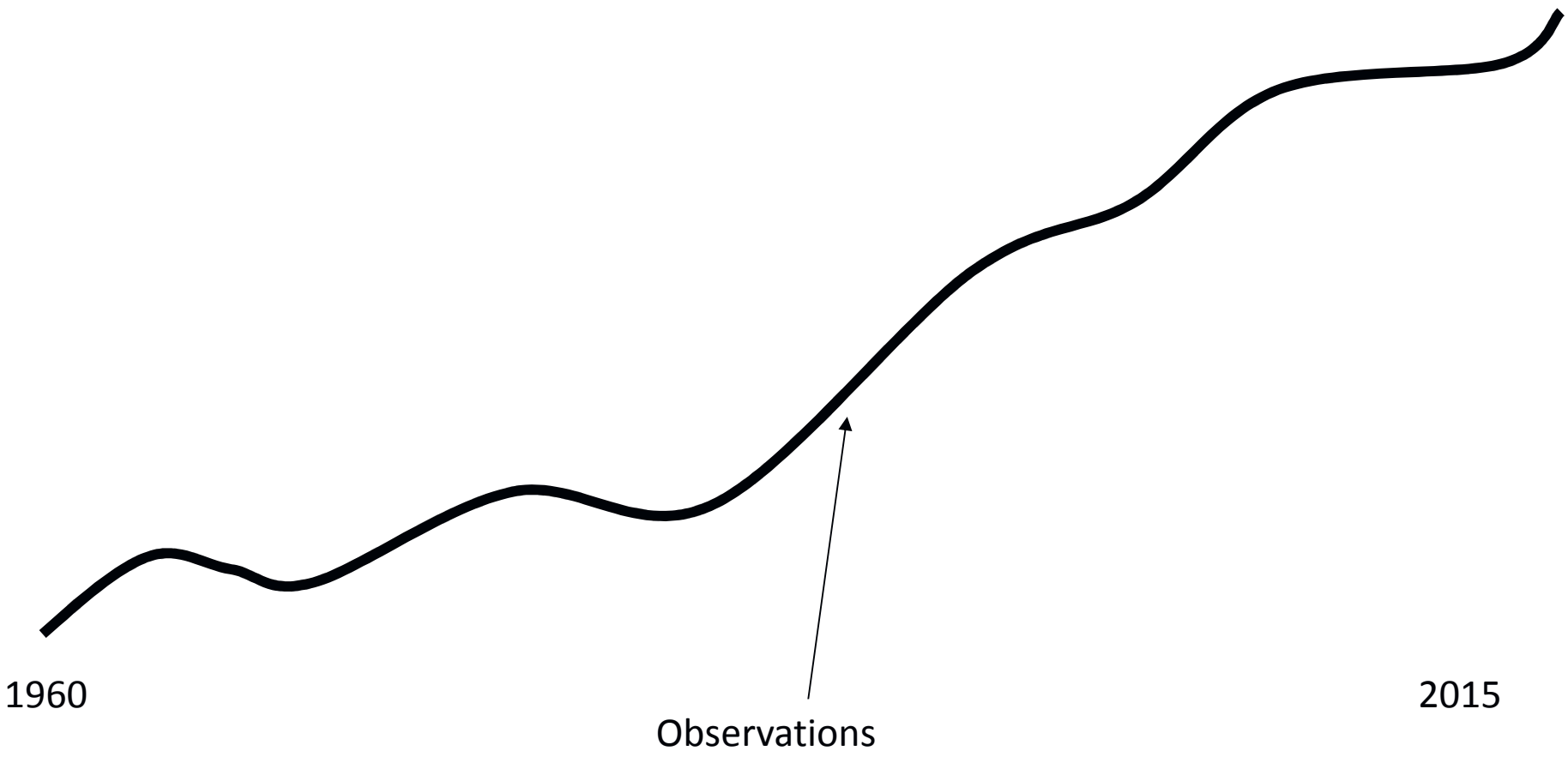
edp renewables
EnBW



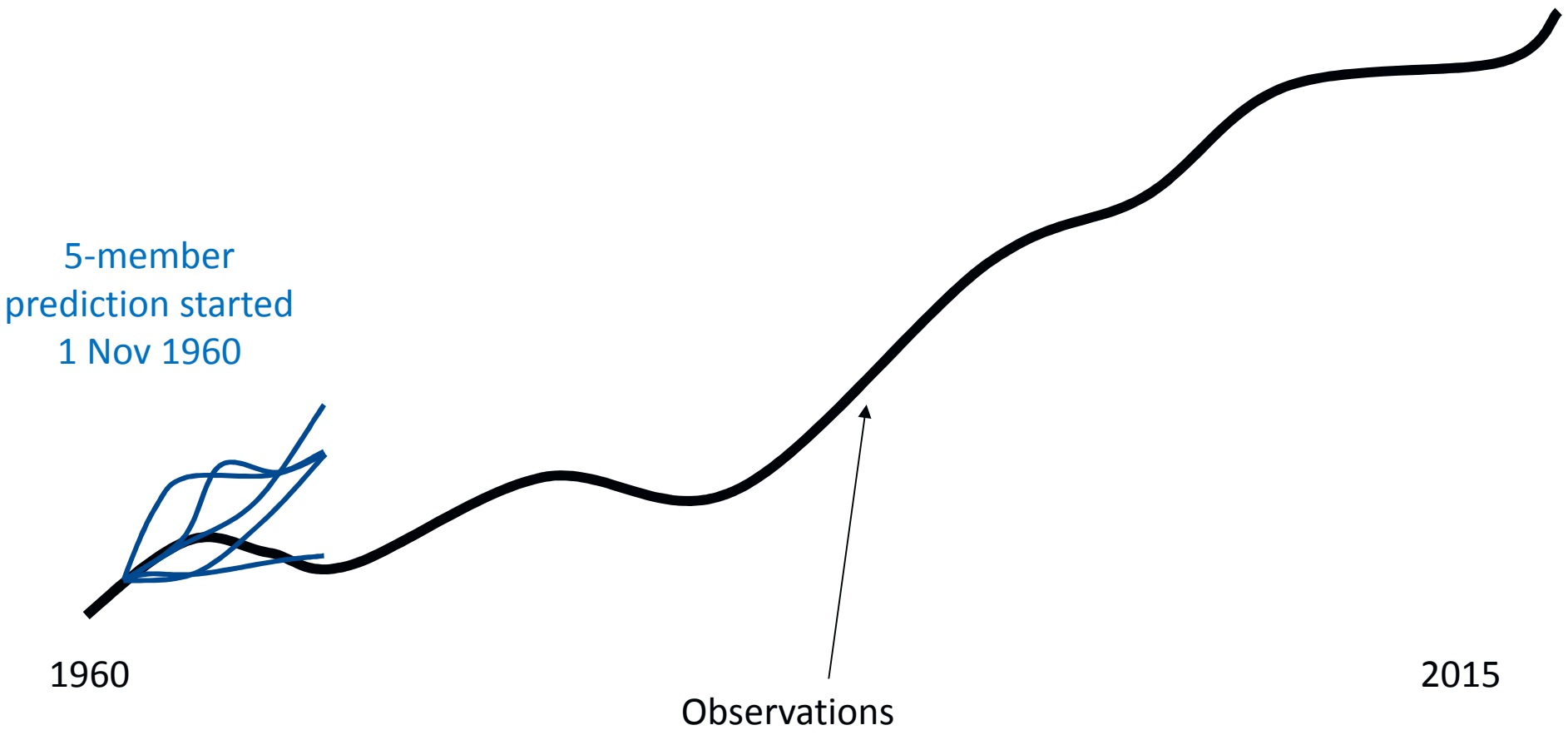
at decadal time-scale:
(e.g. capacity factor ~T2m and 10m.wind)

IBERDROLA RENOVABLES
EDF ENERGY

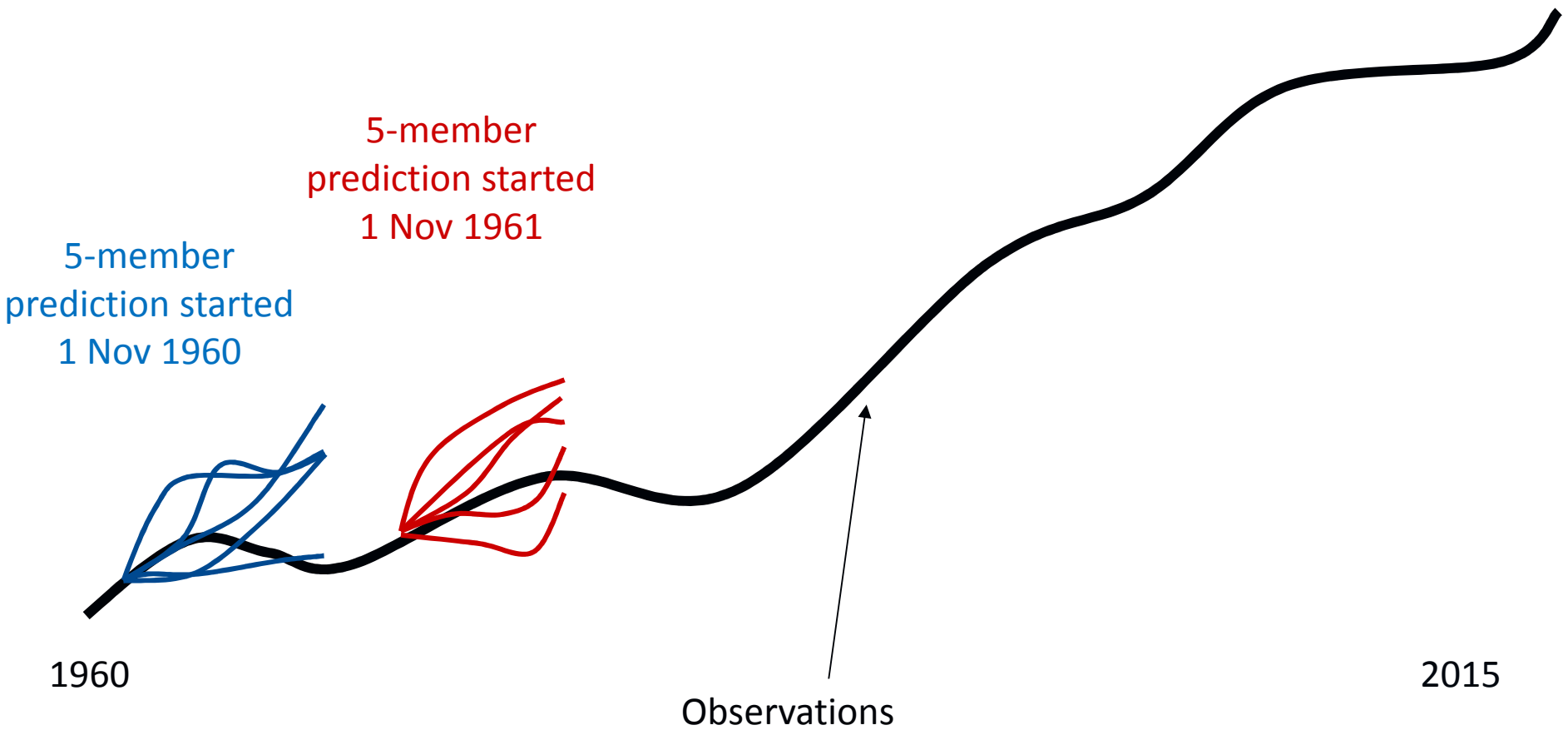
Decadal climate prediction



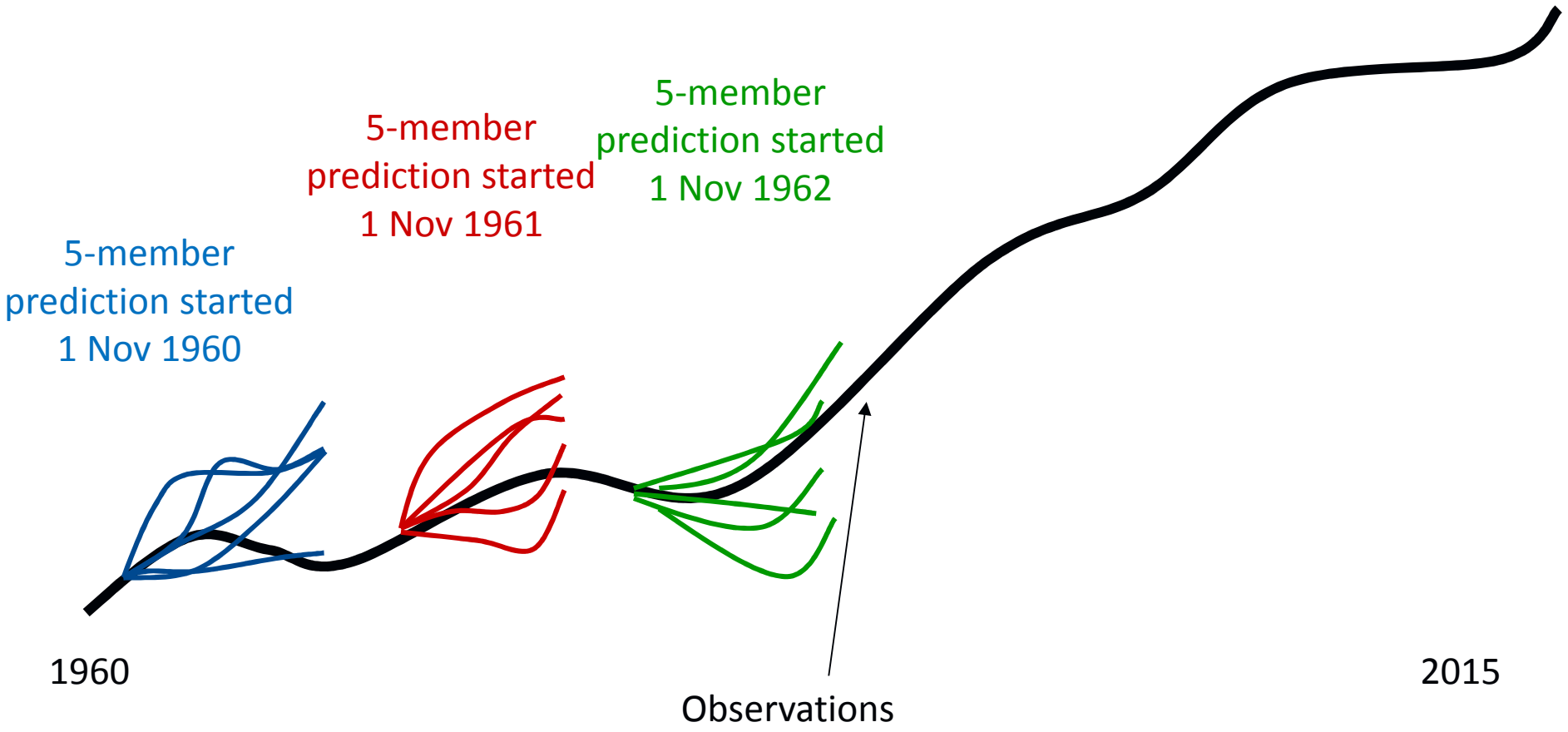
Decadal climate prediction



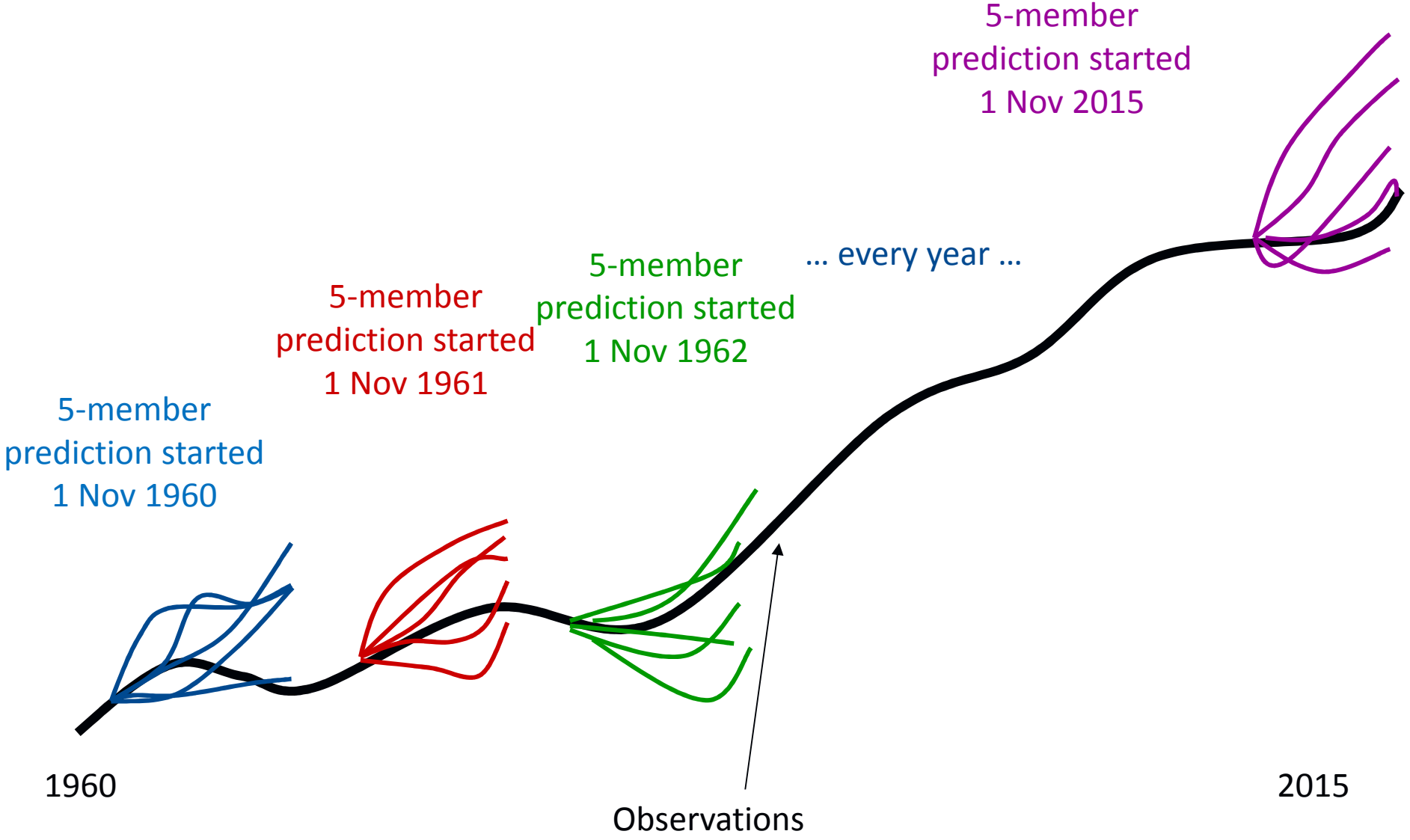
Decadal climate prediction



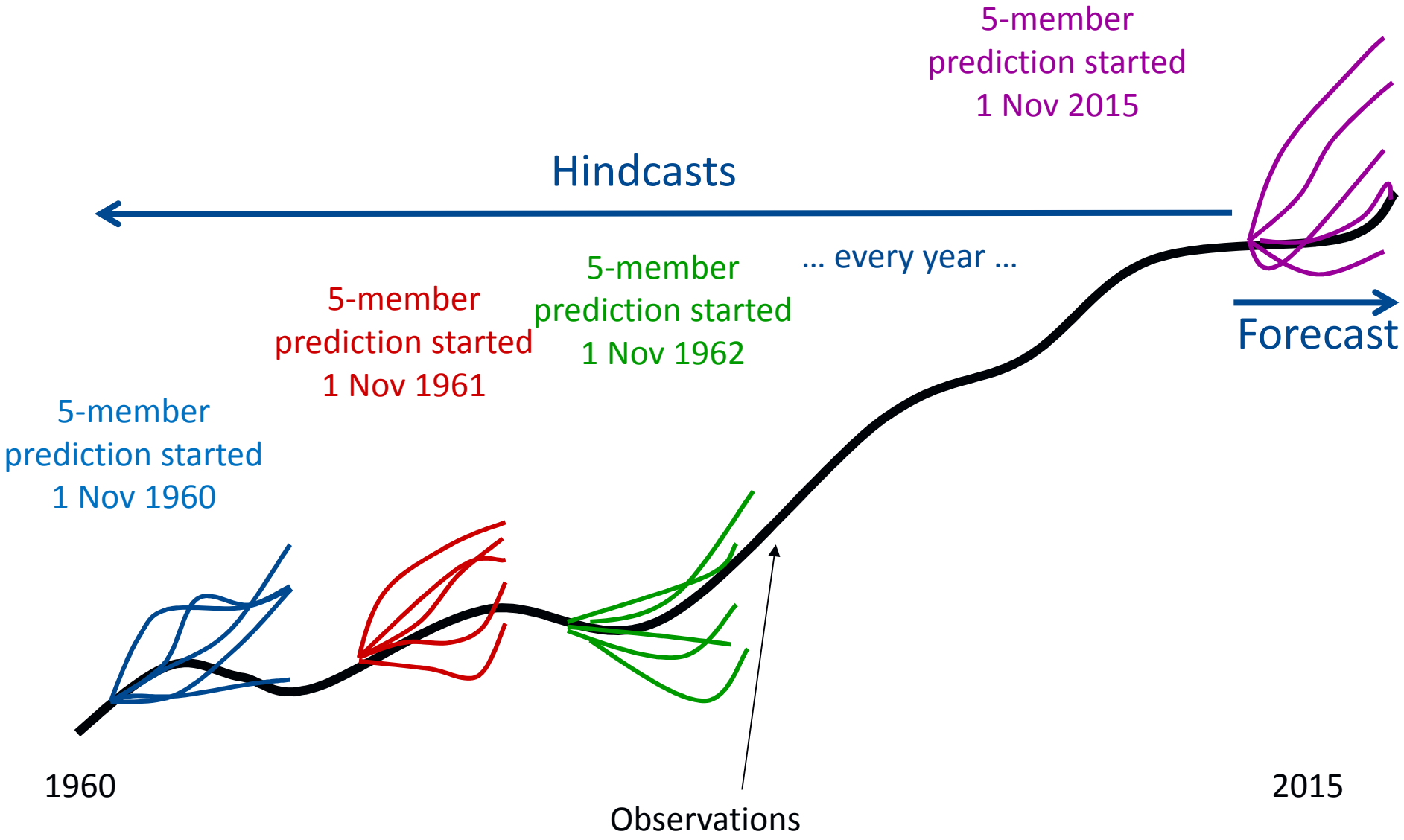
Decadal climate prediction



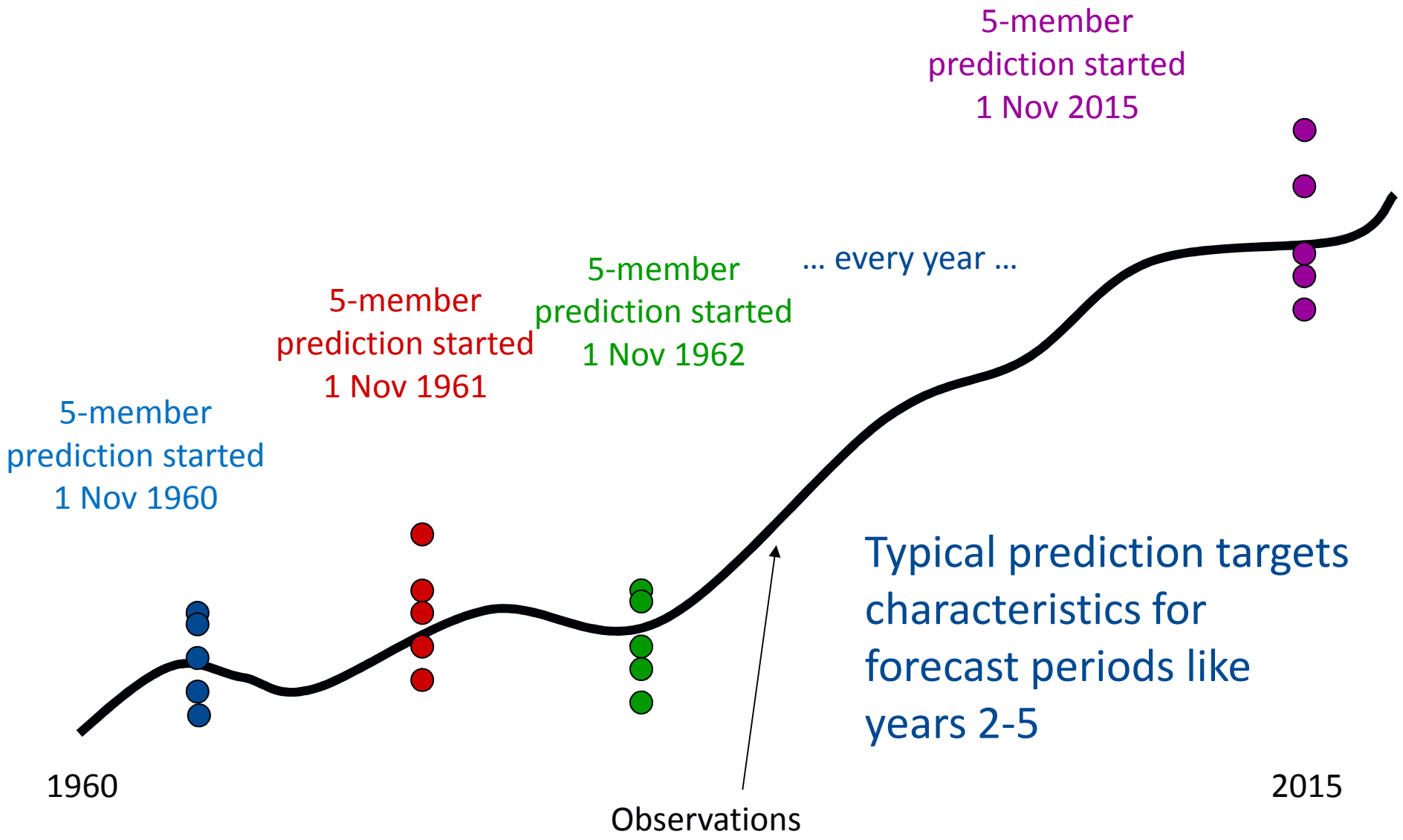
Decadal climate prediction



Decadal climate prediction



Decadal climate prediction



Decadal climate prediction

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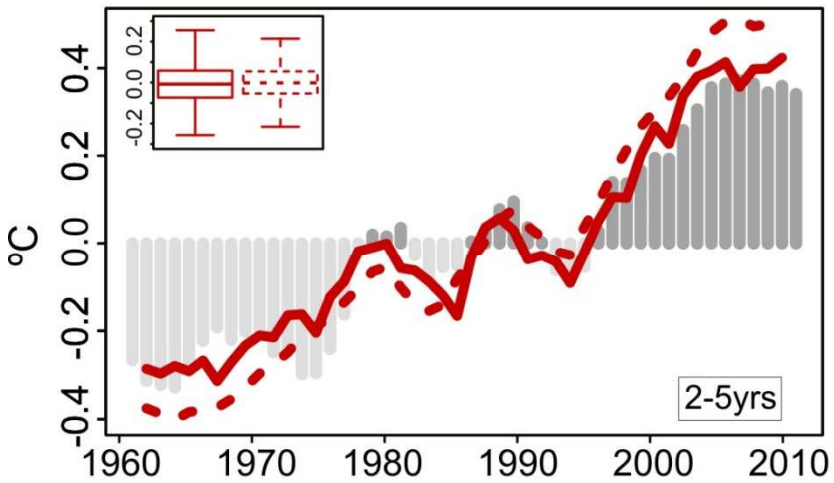
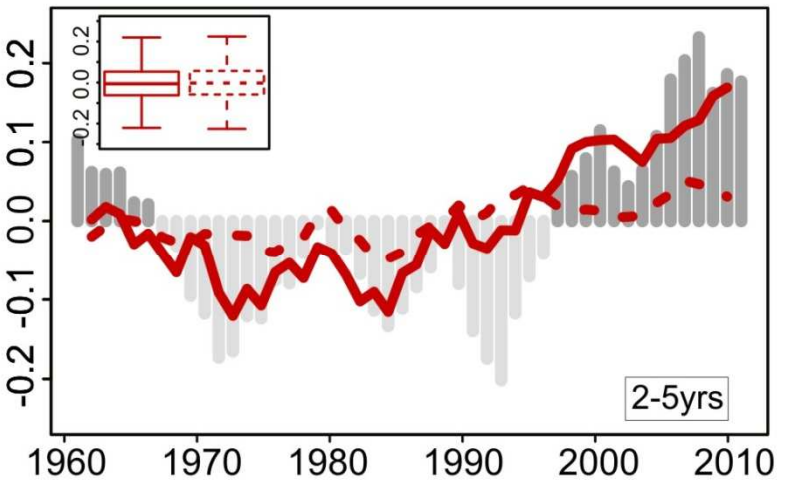
Global-mean surface temperature



Atlantic multi-decadal oscillation (AMO)



Doblas-Reyes et al. (2013, Nature Comms.)

CMIP5 Init CMIP5 NoInit

Decadal climate prediction

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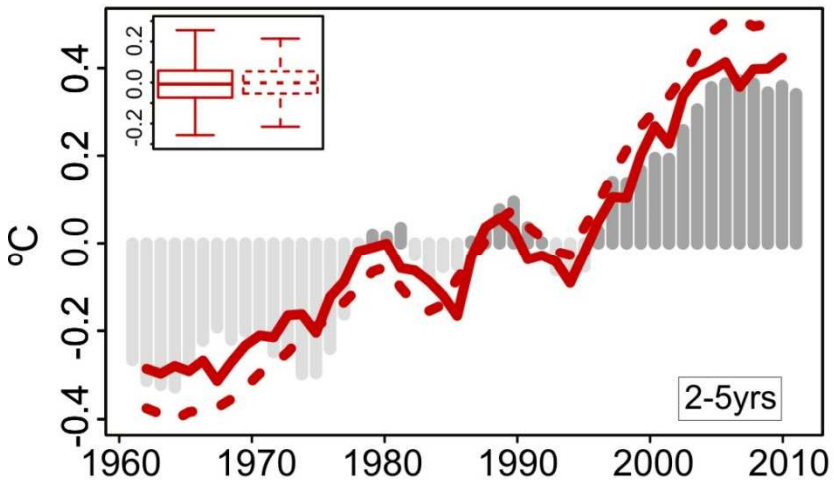
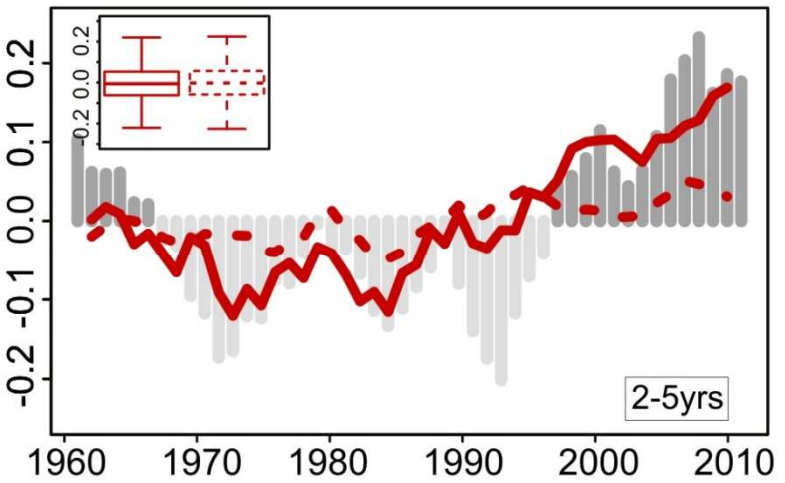
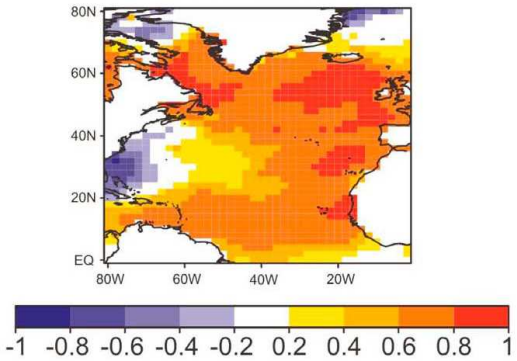
Global-mean surface temperature



Atlantic multi-decadal oscillation (AMO)





García-Serrano et al. (2012, GRL)

Doblas-Reyes et al. (2013, Nature Comms.)

Decadal climate prediction

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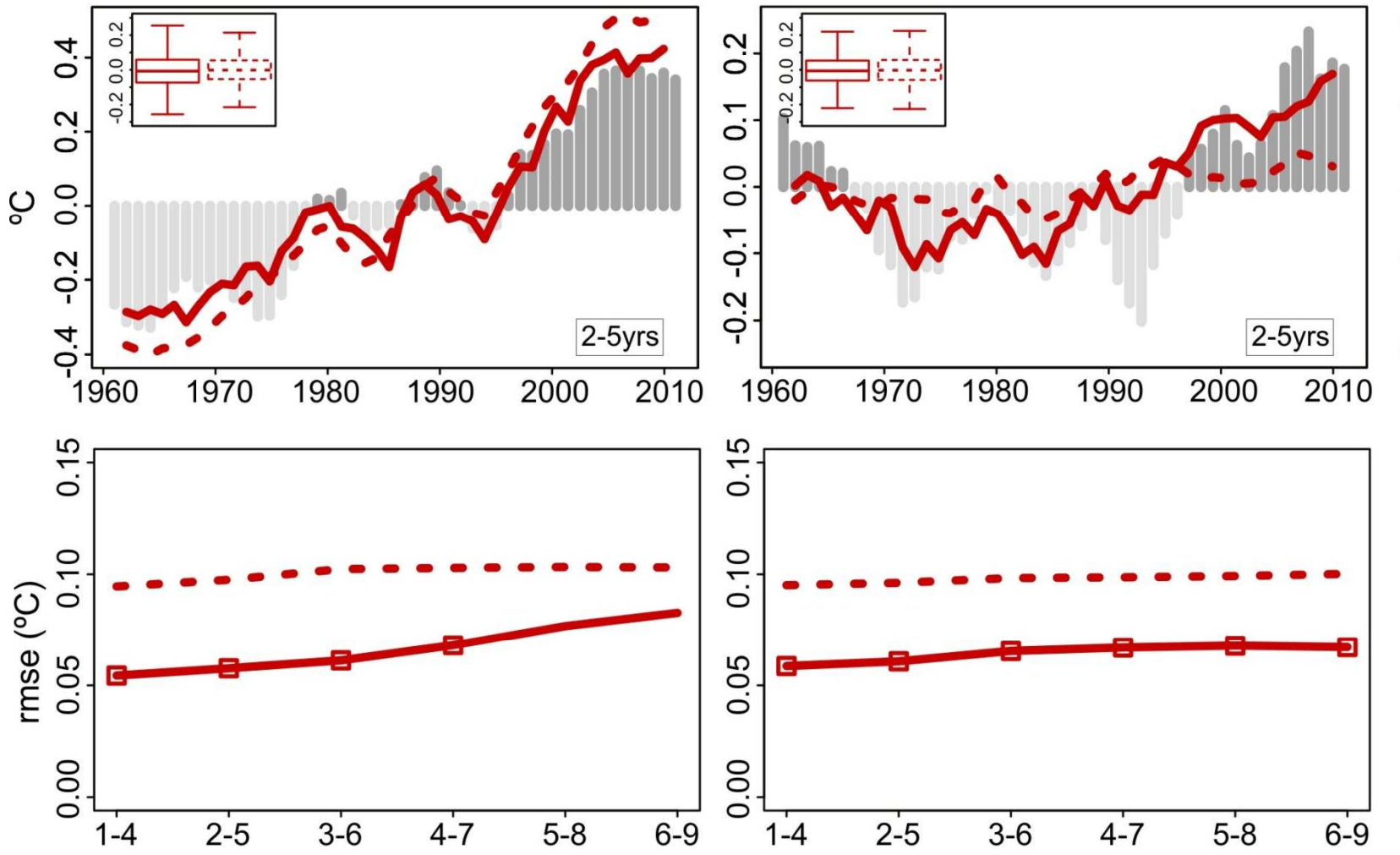
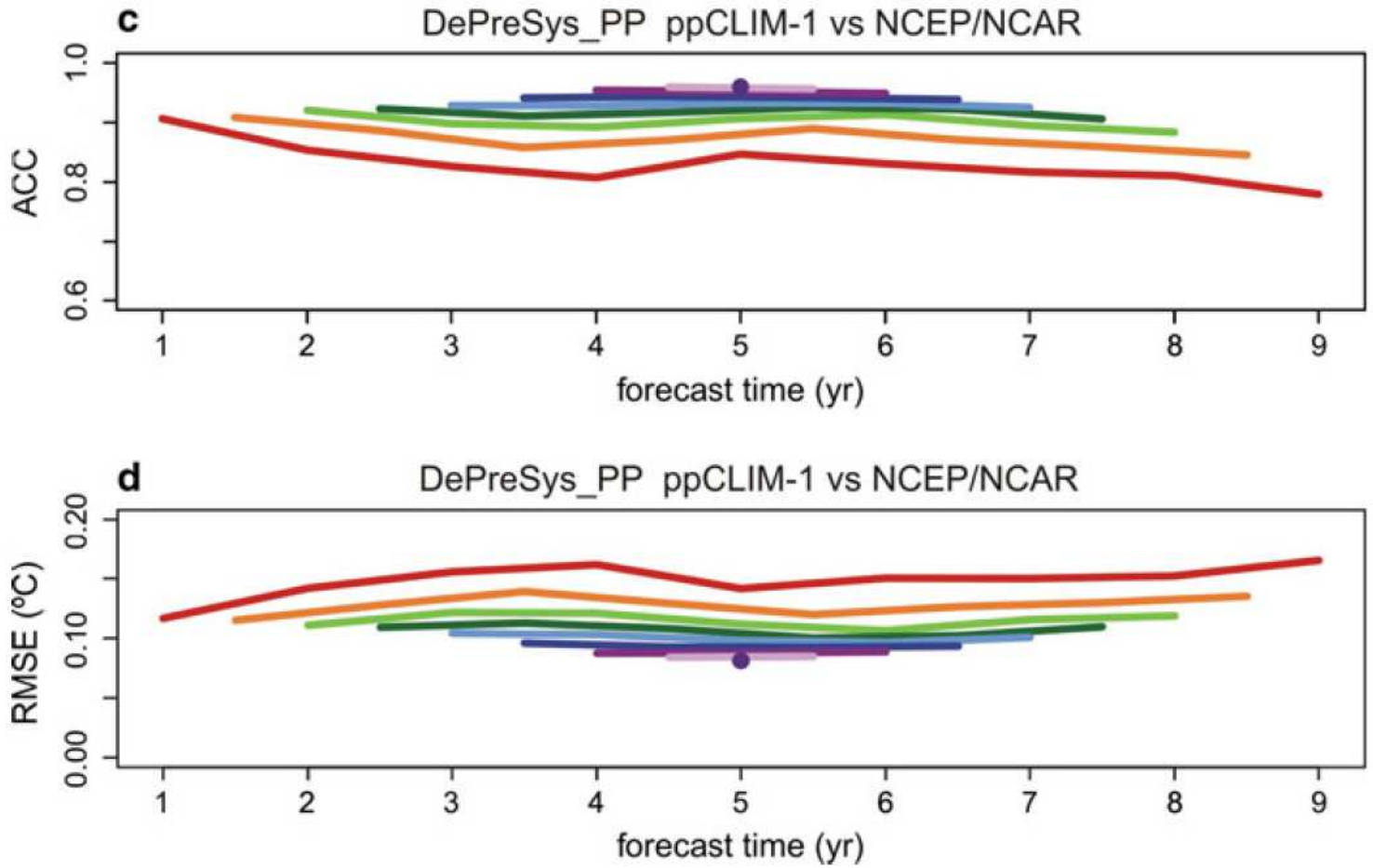
Global-mean surface temperature

Atlantic multi-decadal oscillation (AMO)



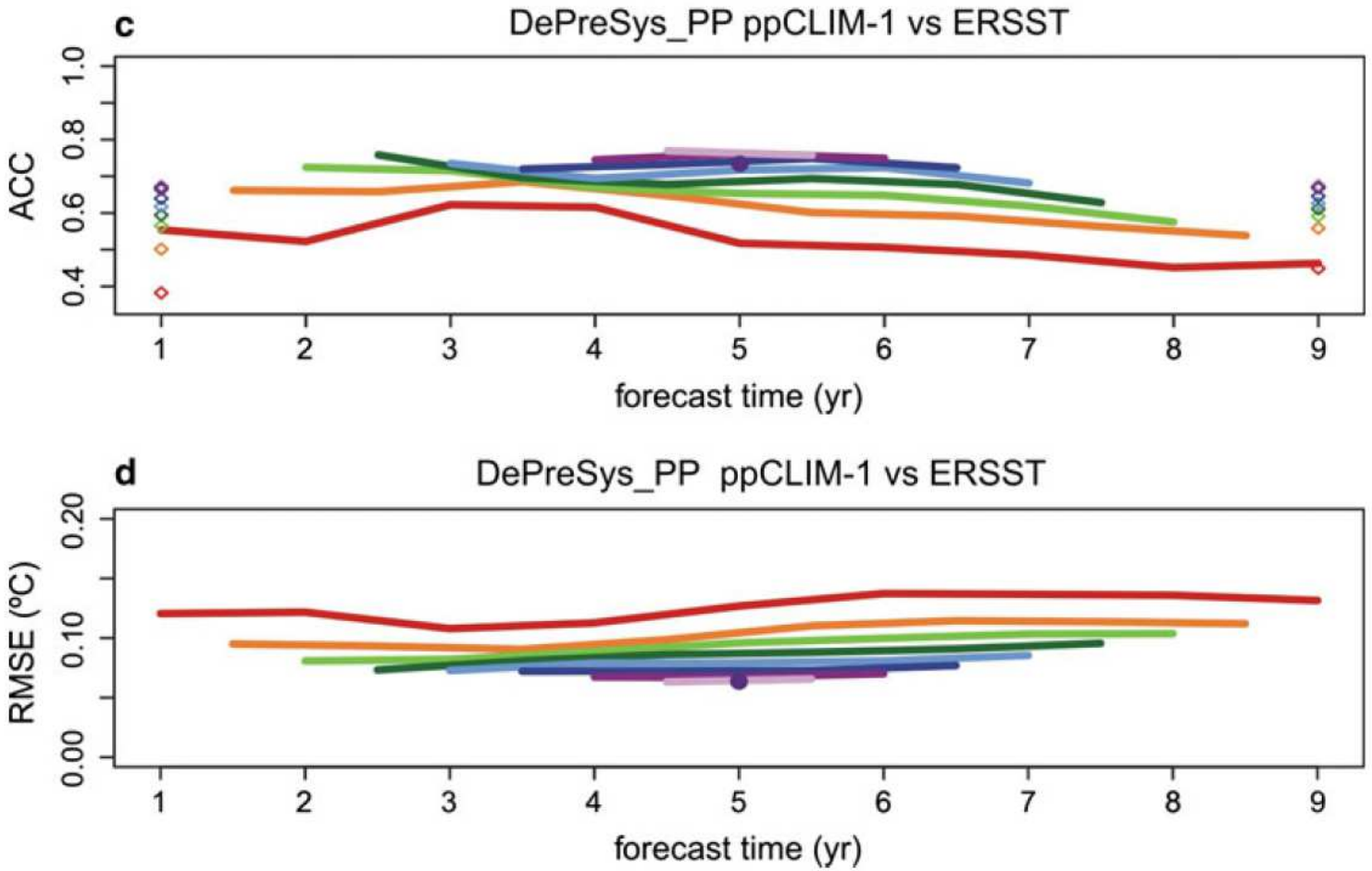
Doblas-Reyes et al. (2013, Nature Comms.)

Global-mean surface temperature



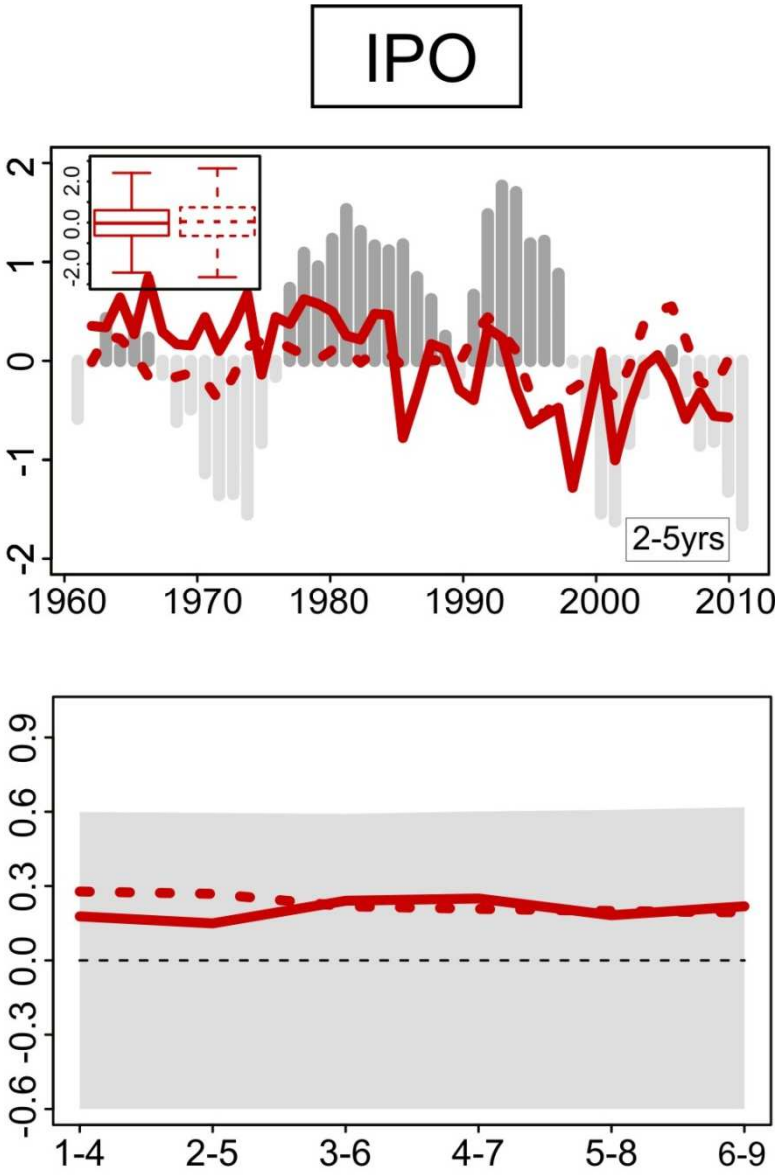
García-Serrano and Doblas-Reyes (2012, ClimDyn)

Atlantic multi-decadal oscillation (AMO)



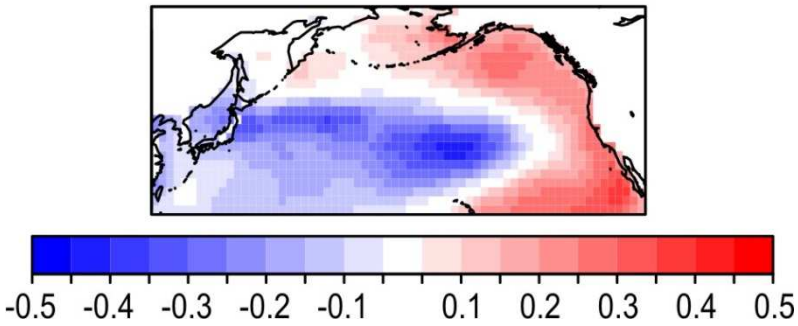
García-Serrano and Doblas-Reyes (2012, ClimDyn)

Decadal climate prediction

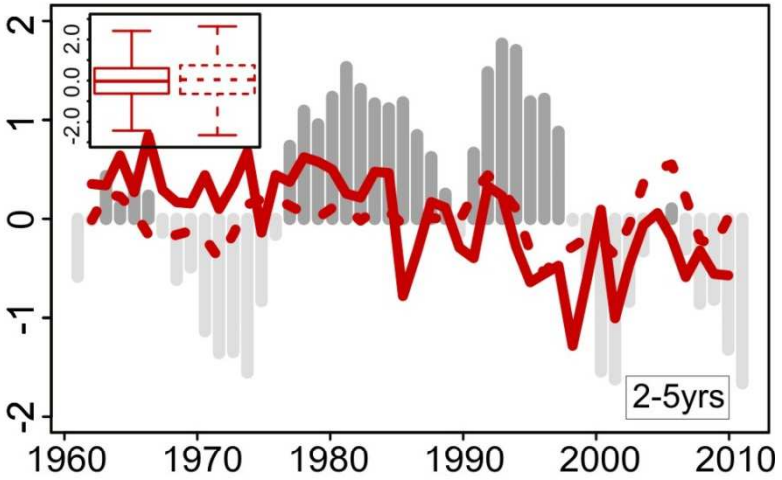


Decadal climate prediction

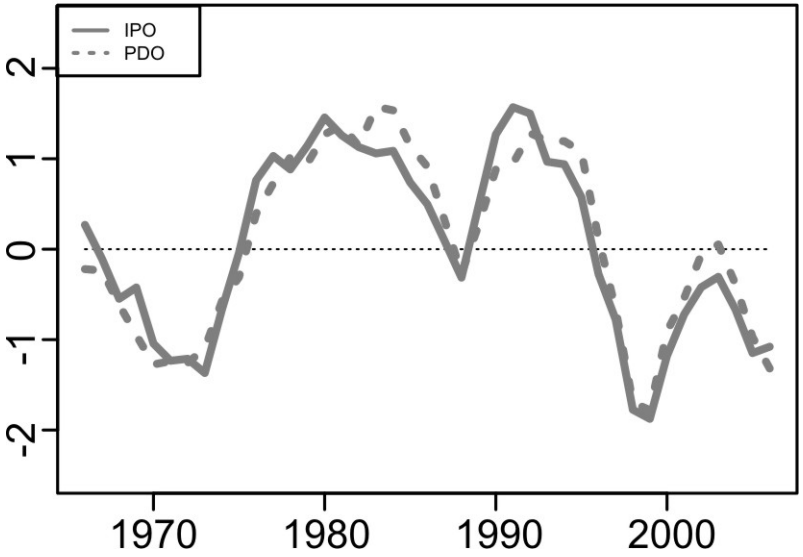
PDO pattern

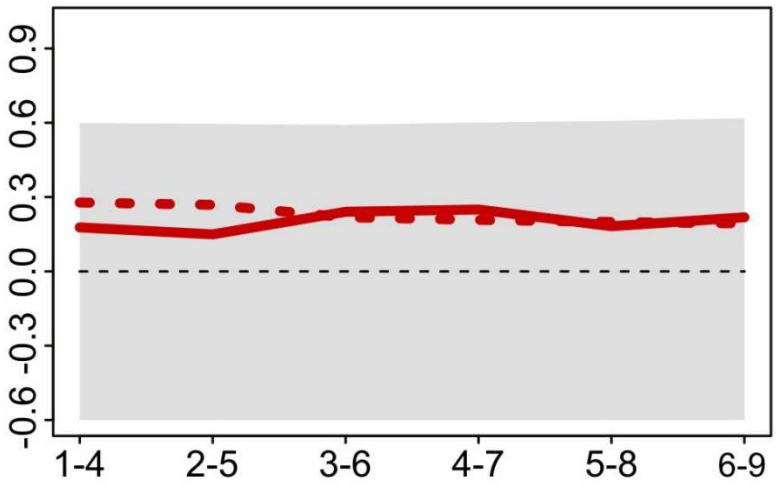


IPO



PDO/IPO 1966/69-2006/09

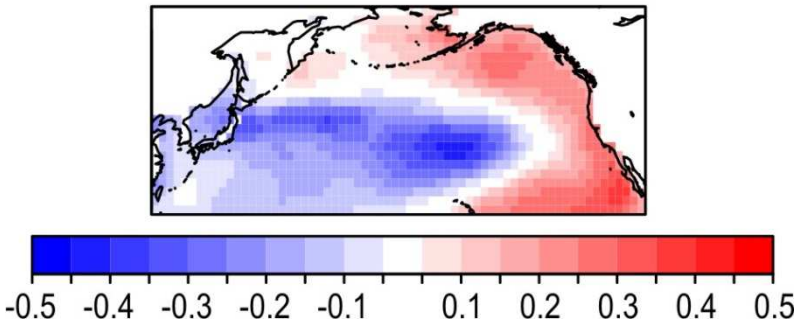




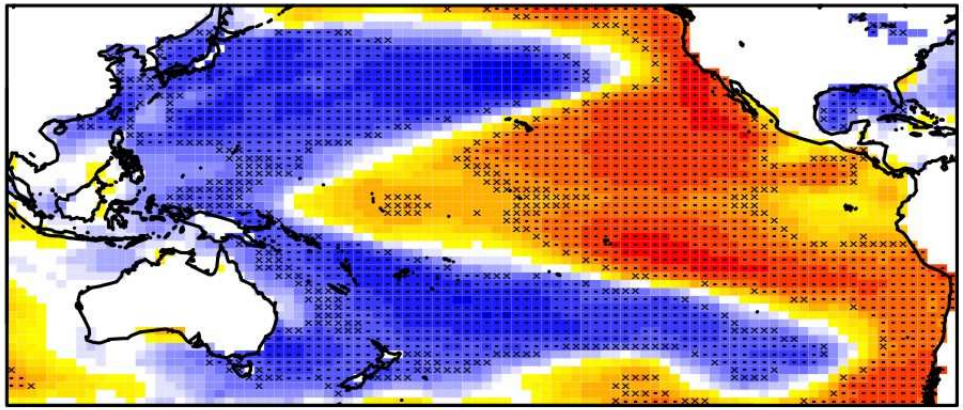
r=0.96

Decadal climate prediction

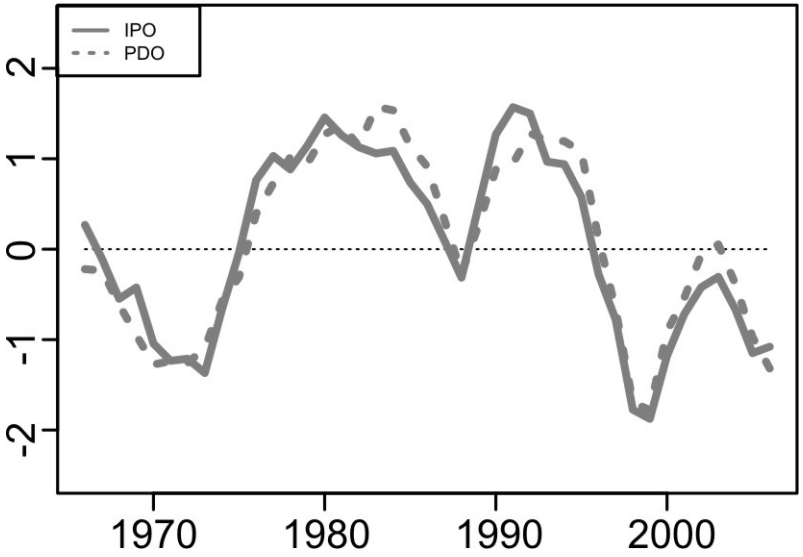
PDO pattern



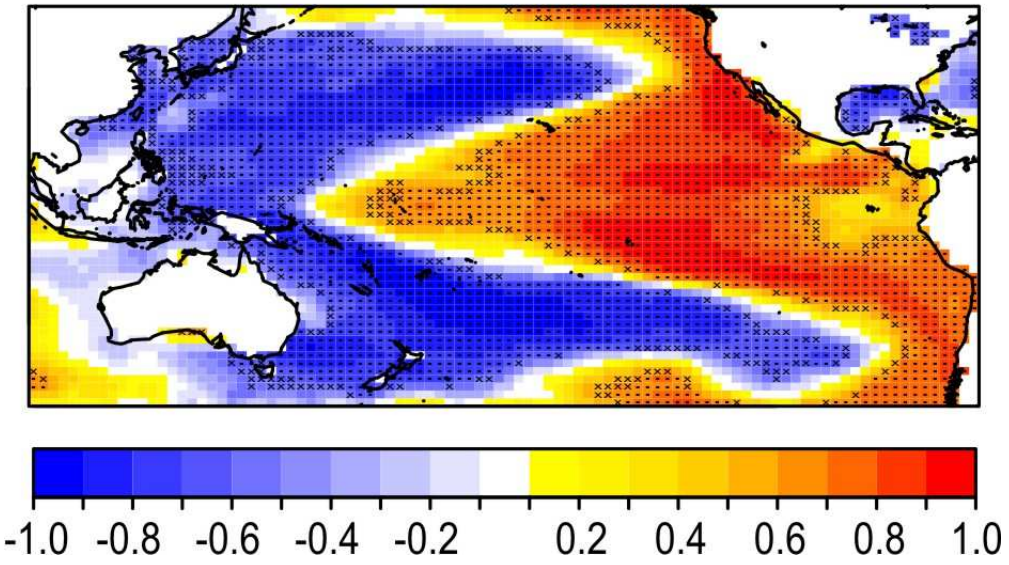
PDO x SST



PDO/IPO 1966/69-2006/09

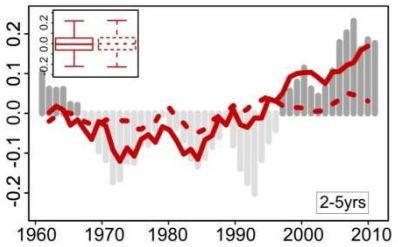


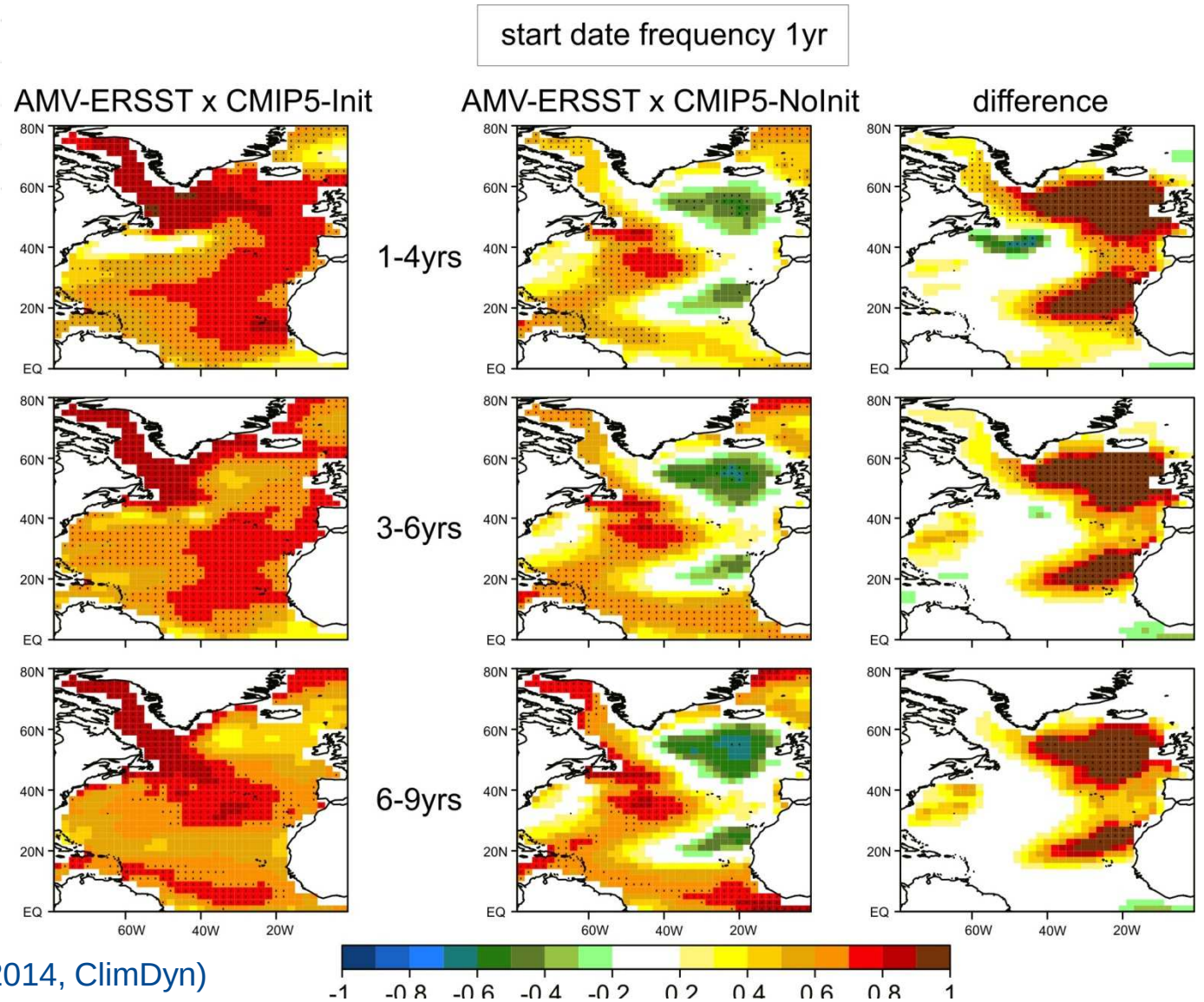
IPO pattern



r=0.96

Correlation at each grid-point between multi-model ensemble-mean detrended SST and observed (ERSST) AMV index for INIT [left] and NoINIT [middle]





García-Serrano et al. (2014, ClimDyn)

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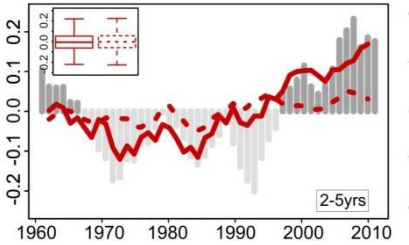
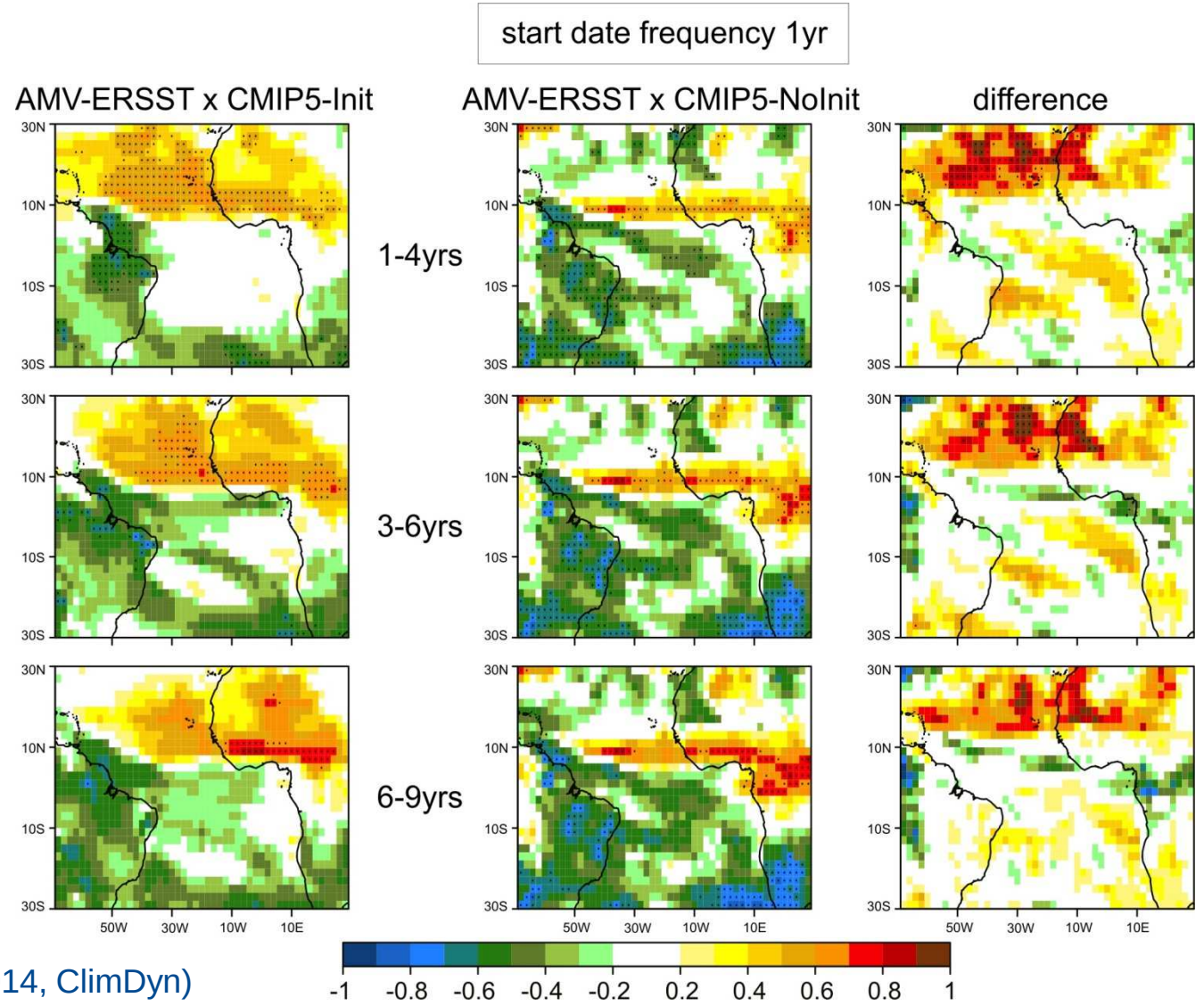
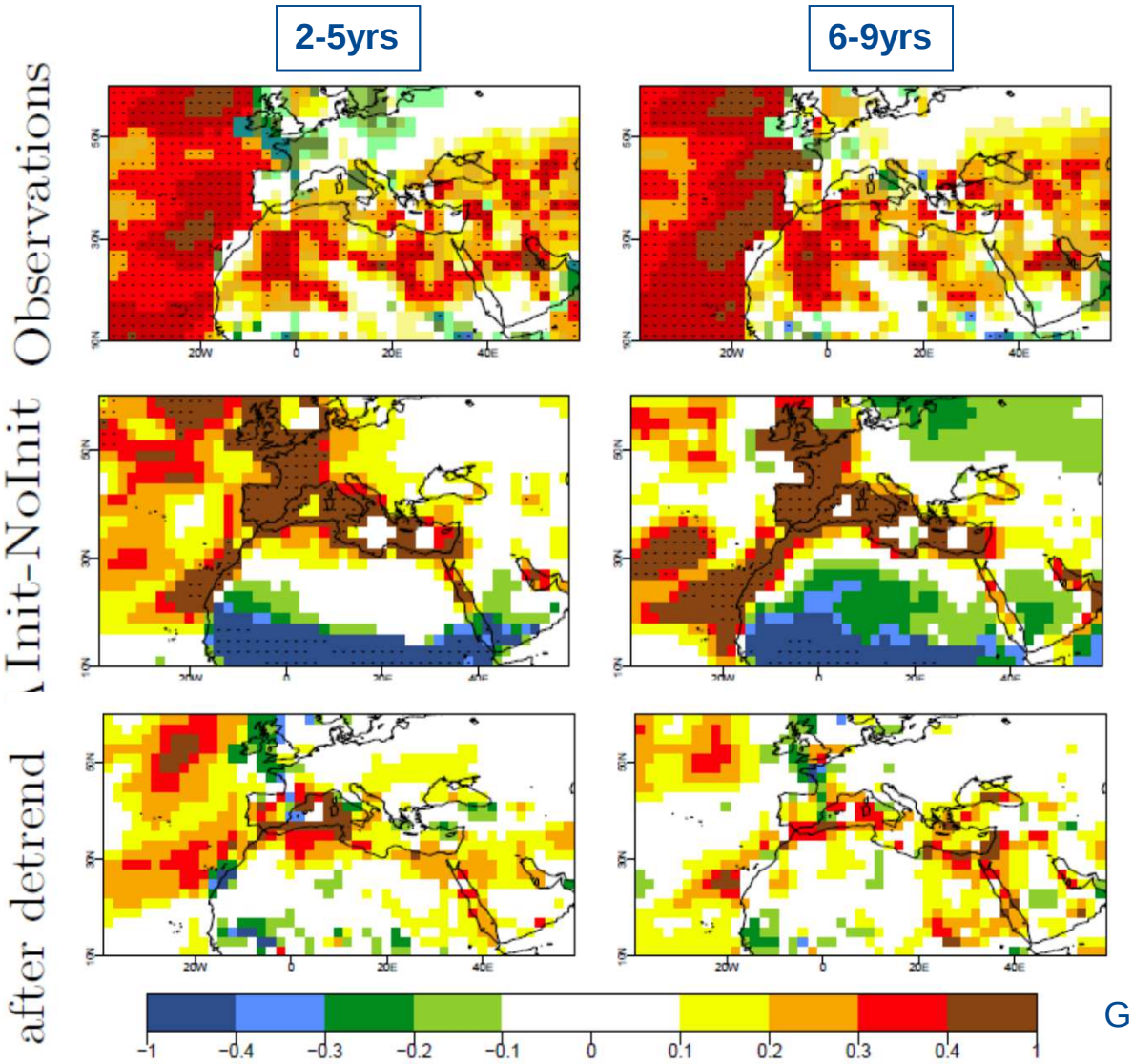
Correlation at each grid-point between multi-model ensemble-mean precipitation and observed (ERSST) AMV index for INIT [left] and NoINIT [middle]





García-Serrano et al. (2014, ClimDyn)

Correlation maps of observational [top] and multi-model ensemble-mean [middle] (INIT-NoINT) detrended surface temperature anomalies and the AMV index; [bottom] skill difference (INIT-NoINIT) of detrended surface temperature anomalies



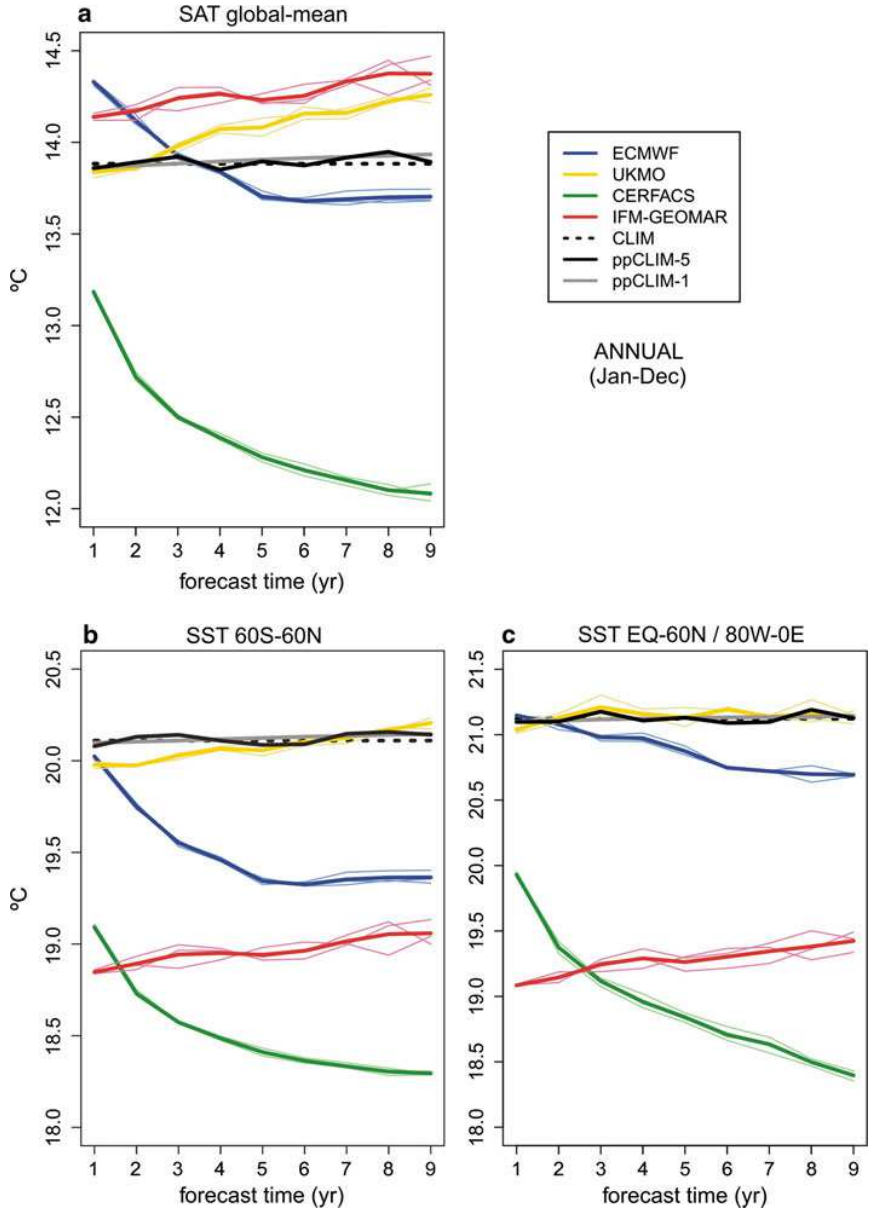
Guemas et al. (2015)

CMIP6 decadal MIP: DCPP

- Formulate an appropriate and relevant scientific question
- Three components: hindcasts, forecasts, predictability
- Decadal prediction will benefit from being part of CMIP6:
  - better understanding (to, hopefully, reduce the drift) the systematic error
  - control runs for predictability estimates
- Other MIPs could benefit from the decadal-prediction MIP:
  - reduction of the systematic error by understanding the drift sources
  - continuous verification of the models
- Decadal prediction could be a very expensive part of CMIP
- Real-time decadal prediction exchange will continue and be enhanced (with more variables) whenever possible
- Contribute to climate services and WCRP grand challenges

EXTRA SLIDES

Decadal climate prediction

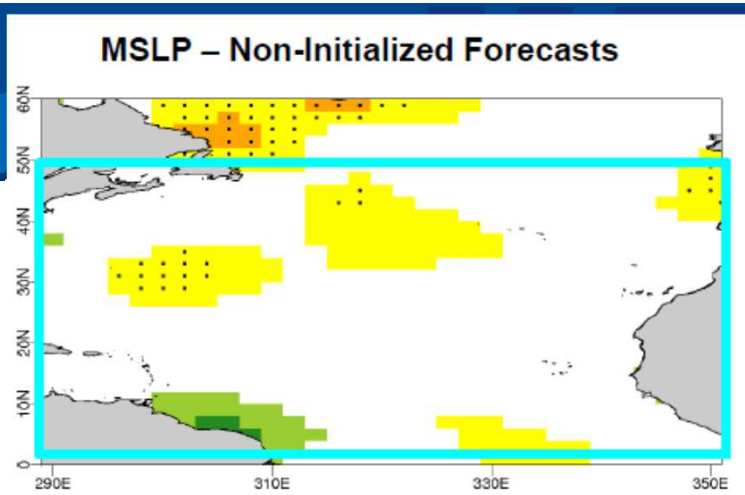


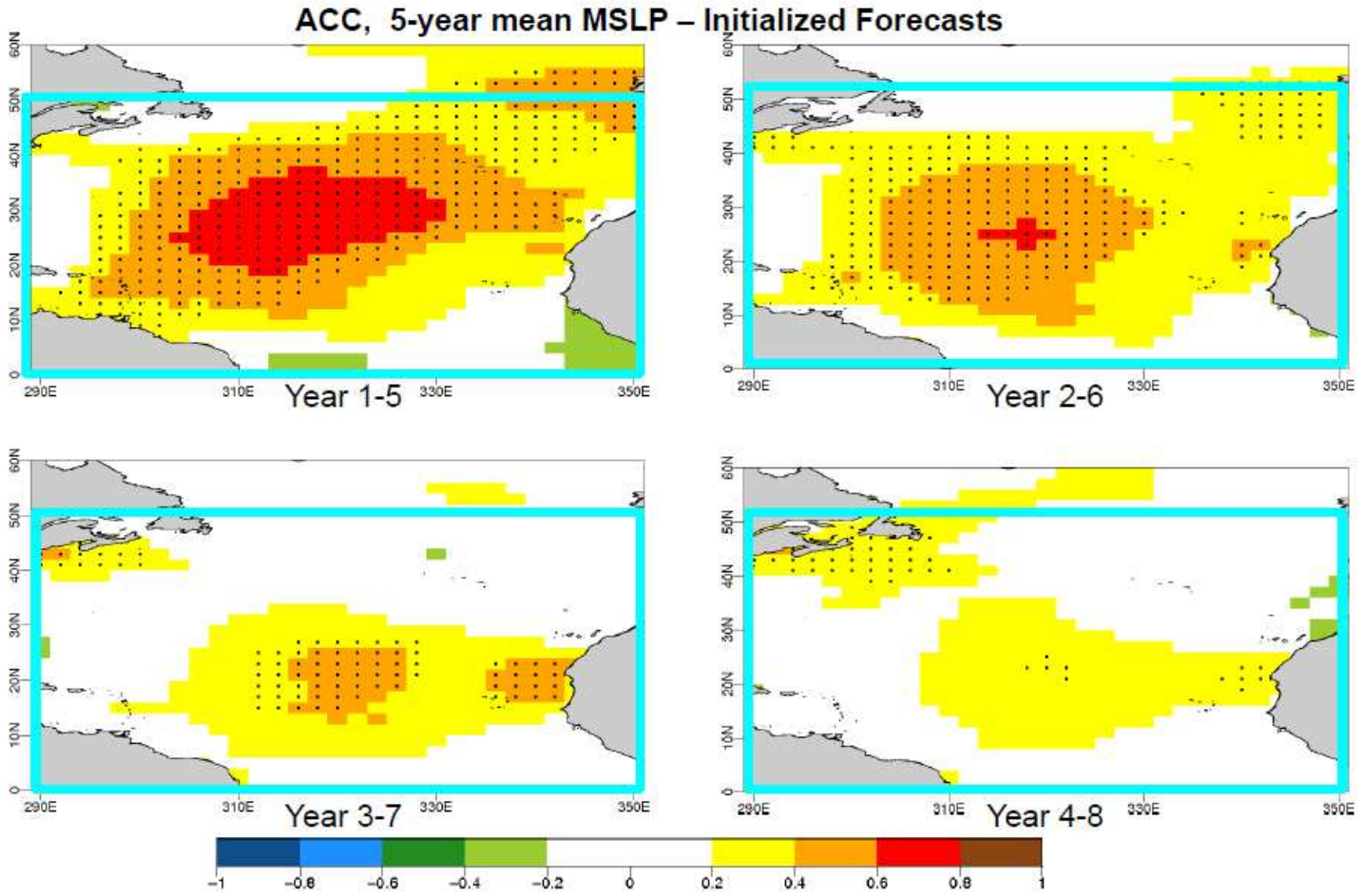
García-Serrano and Doblas-Reyes (2012, ClimDyn)

Decadal climate prediction

GCMs	Initialized	Non-Initialized
GFDL CM2.1	10	10
HadCM3	10	10
MIROC5	6	3
MPI-ESM-LR	5	3

Start dates: yearly, 1961 to 2009
5-year mean predictions (1961-1966 to 2009-2013)

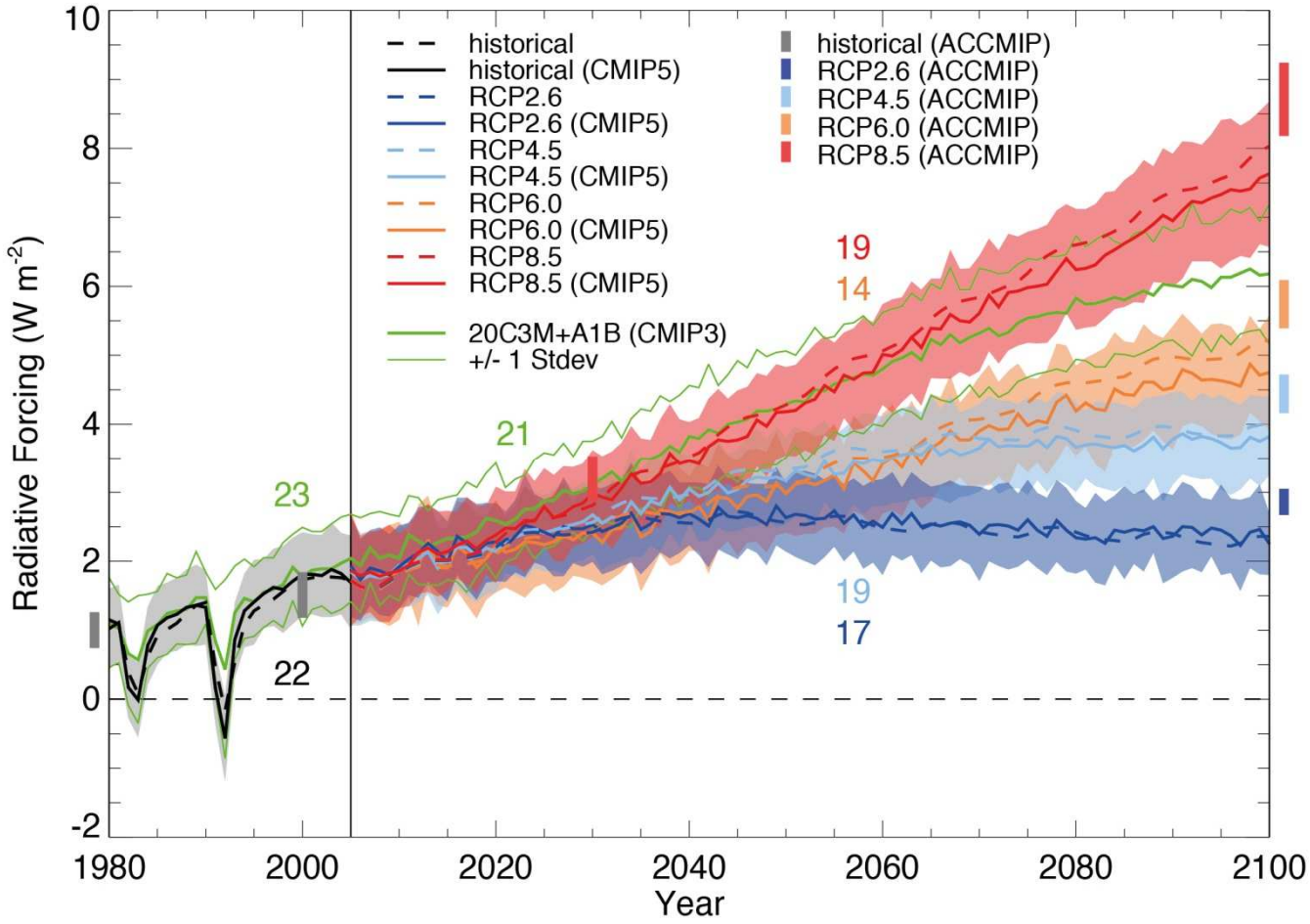




Caron et al. (2015, GRL)

Global mean radiative forcing (Wm^{-2}, dashed) and effective radiative forcing (solid) between 1980 and 2100 with 1850 as baseline.

There is little difference between the RCPs before 2040.



IPCC AR5 WGI (2013)

Decadal climate prediction

Barcelona Supercomputing Center
Centro Nacional de Supercomputación
EXCELENCIA SEVERO OCHOA

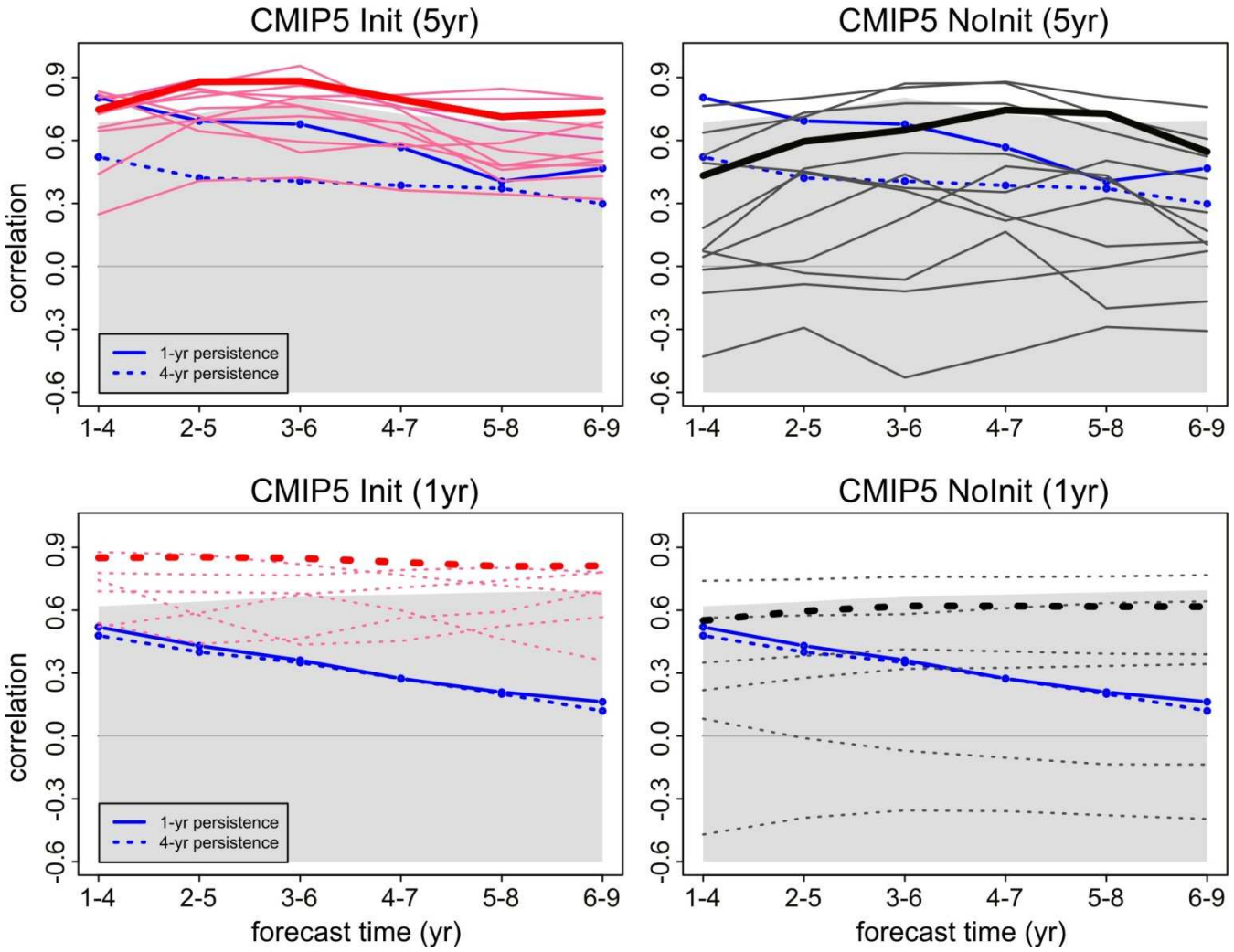
CMIP5 (initialized) hindcasts + historical&RCP4.5:

- 10-year long
- ensemble size & start date frequency: variable
- multi-model: 11 systems (5-yr) / 6 systems (1-yr)
- over the period 1960-2005

forecast system	members		start date frequency
	Init	NoInit	
HadCM3	10	10	5yr / 1yr
MRI-CGCM3	9	1	5yr
MIROC4h	3	3	5yr
MIROC5	6	1	5yr / 1yr
CanCM4	10	10	5yr / 1yr
CNRM-CM5	10	6	5yr
EC-EARTH2.3	10 / 5	11	5yr / 1yr
CMCC-CM	3	1	5yr
GFDL-CM2	10	10	5yr / 1yr
IPSL-CM5	6	6	5yr
ECHAM5/MPI-OM	10 / 3	10	5yr / 1yr

García-Serrano et al. (2014, ClimDyn)

AMV forecast skill



Branstator and Teng (2012): inter-model differences in forced predictability larger than in initial-value predictability

Terray (2012): marked inter-model spread in the spatial response to anthropogenic forcing

EC-EARTH2.3 forecast system

- NEMO2: ORCA1 L46
- IFS [cy31r1]: T159 L62 (top 5hPa)
- LIM2: single ice category
- H-TESSEL – land-surface processes
- OASIS3 – coupler

initial conditions

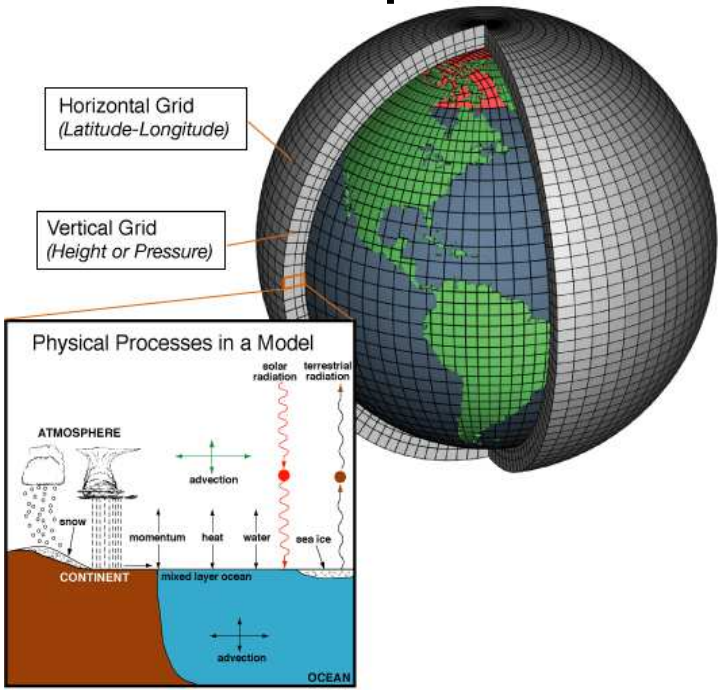
atmosphere reanalysis (ERA-Interim)

ice reanalysis (IC3/BSC)

land reanalysis (ERA-Land)

ocean reanalysis (e.g. ORAS4)

EC-EARTH coupled model



EC-EARTH3.2 forecast system

- NEMO3.6: ORCA1 L75
- IFS [cy36r4]: T255 L91 (top 0.01hPa)
- LIM3: multiple (5) ice categories
- H-TESSEL – land-surface processes
- OASIS3-MCT – coupler

initial conditions

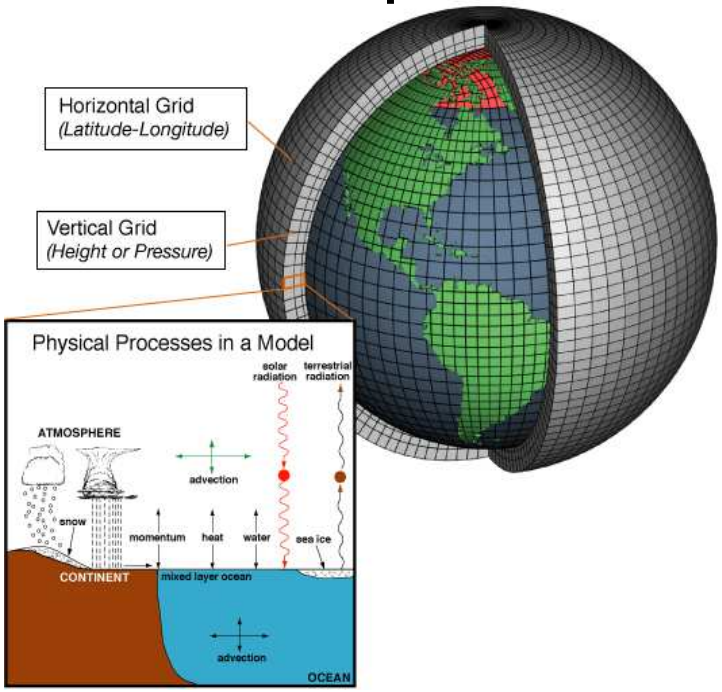
atmosphere reanalysis (ERA-Interim)

ice reanalysis (IC3/BSC)

land reanalysis (ERA-Land)

ocean reanalysis (e.g. ORAS4)

EC-EARTH coupled model

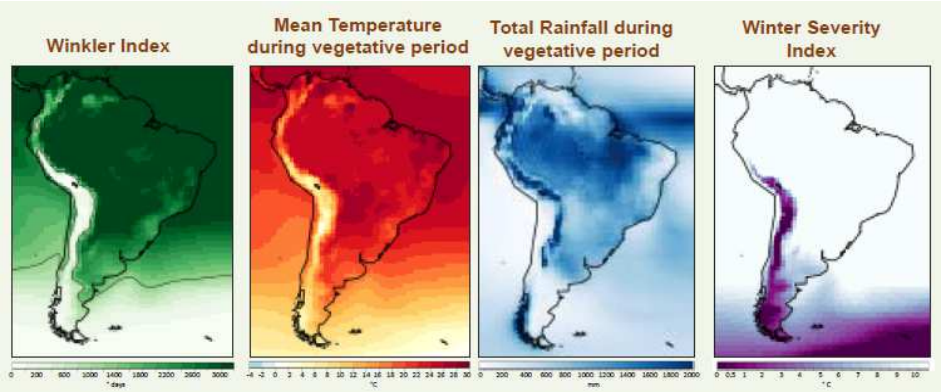


Co-design of Wine Indices

In this study, four wine indices were defined in the co-design phase with the stakeholders (a wine company). Their main difference with the standard wine indices is that their definition is adapted to the Southern Hemisphere, where the warmest months are from October to April:

- The **Winter Severity Index** is the mean temperature of the coldest month (July in the Southern Hemisphere).
- The **Winkler Index** is the cumulated sum from October to April of all the degrees of daily mean temperature above 10°C.
- The **Mean Temperature during the vegetative period** is the average mean temperature from October to April.
- The **Total Rainfall during the vegetative period** is the total precipitation amount from October to April.

The selection is conditioned on the availability of climate models and observations in the study area. For example, in South America there are few observational datasets and few regional models available. In this cases, it is preferable to employ daily reanalysis datasets and global climate models instead (in this study, respectively the ERA-Interim and the CMIP5 models).



VIÑAS DEL VERO

SOGRAPE VINHOS

CODORNÍU

RAIMAT

TORRES
1870

Decadal climate prediction → 'climate services'

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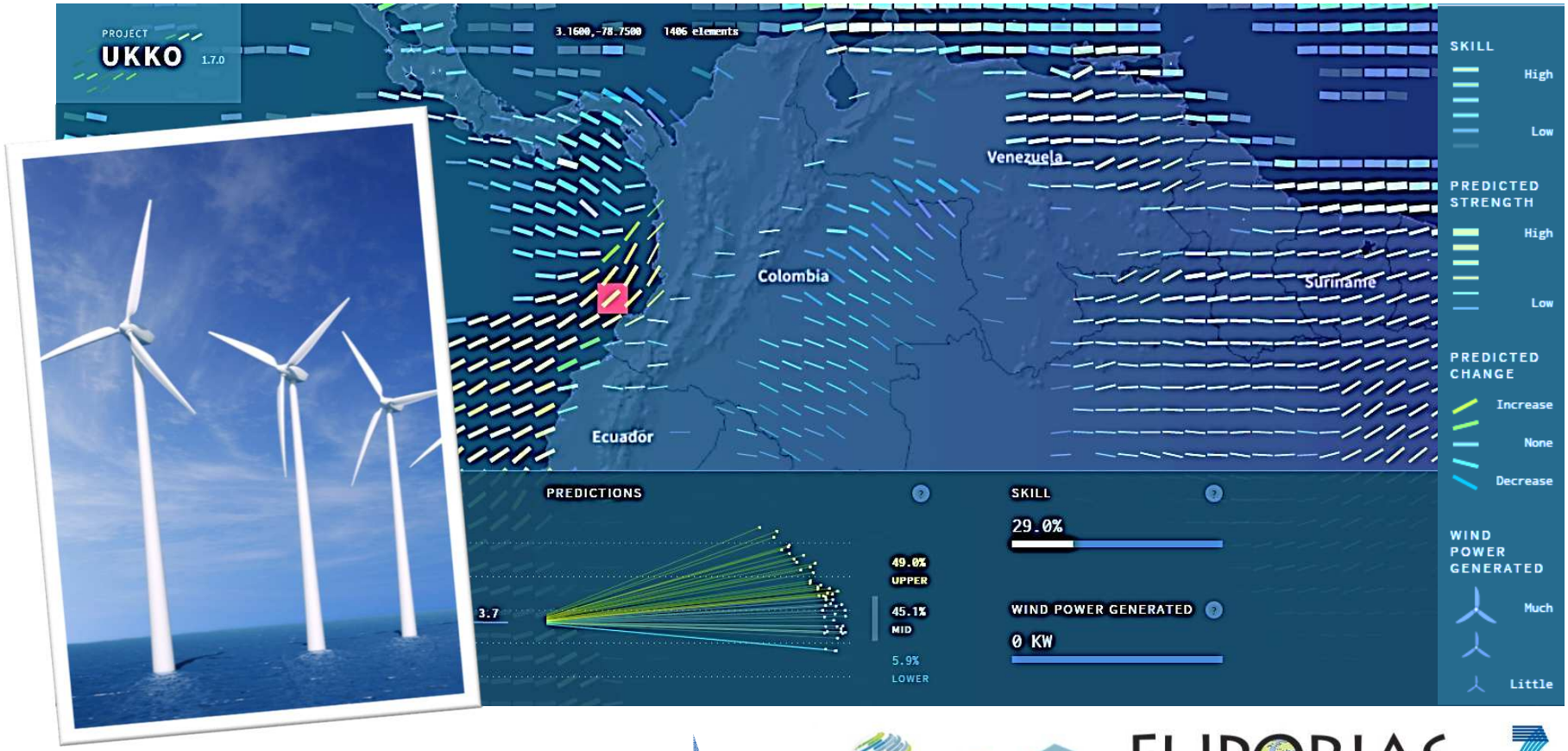

RESILIENCE PROTOTYPE

SPECS
EUPORIAS
SEVENTH FRAMEWORK PROGRAMME
Clim4Energy
NEWA
eDF
edp renewables
ALSTOM
VORTEX
natural power
EnBW